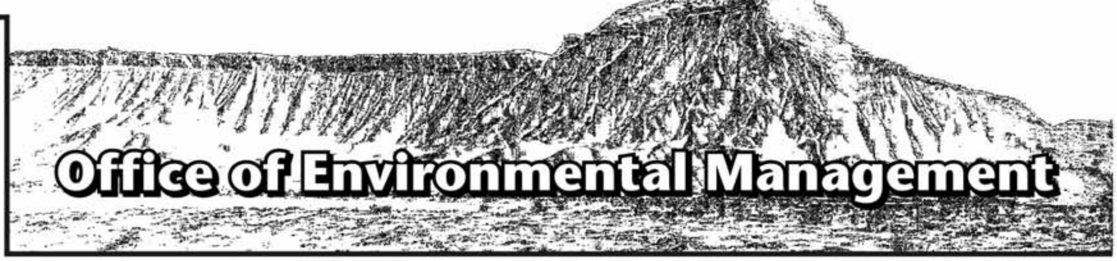
DOE–EM/GJ777–2004

Hanford Tank Farms Vadose Zone Monitoring Project

Annual Monitoring Report for Fiscal Year 2004

January 2005

U.S. Department of Energy



Work Performed Under DOE Contract No. DE–AC01–02GJ79491 for the U.S. Department of Energy, Grand Junction, Colorado.
Approved for public release; distribution is unlimited.

DOE-EM/GJ777-2004

Hanford Tank Farms Vadose Zone Monitoring Project

Annual Monitoring Report for Fiscal Year 2004

January 2005

Prepared for
U.S. Department of Energy
Office of Environmental Management
Grand Junction, Colorado

Prepared by
S.M. Stoller Corp.
Grand Junction, Colorado

Approved for public release; distribution is unlimited.
Work performed under DOE Contract No. DE-AC01-02GJ79491.

Contents

Contents (continued)

Page

List of Tables

Hanford Tank Farms Vadose Zone Monitoring Project
Annual Monitoring Report for Fiscal Year 2004

Prepared by:

A.W. Pearson
S.M. Stoller, Hanford

1/26/05
Date

Concurrence:

R.G. McCain, Hanford Technical Lead
S.M. Stoller, Hanford

1/26/05
Date

Approved by:

Brian Mathis, Manager
S.M. Stoller, Hanford

1/26/05
Date

Robert Yasek, Project Manager
U.S. Department of Energy
Office of River Protection

1/27/05
Date

1.0 Introduction

The Hanford Tank Farms Vadose Zone Monitoring Project (VZMP) was established in fiscal year (FY) 2001 for comprehensive routine monitoring of existing boreholes in Hanford single-shell tank farms. The logging system used for monitoring is the Radionuclide Assessment System (RAS). A baseline record of existing contamination associated with gamma-emitting radionuclides in the vadose zone was established between 1995 and 2000 using the Spectral Gamma Logging System (SGLS). Although less precise, the RAS is a simpler, faster, and more cost-effective logging system than the SGLS. Measurements collected with the RAS can be compared to the baseline data to assess the long-term stability of the radionuclide contaminant profile. When routine monitoring identifies anomalies relative to the baseline, these anomalies may be investigated using the SGLS, the High Rate Logging System (HRLS), and/or the Neutron Moisture Logging System (NMLS). The HRLS is also used to collect data in boreholes where the contaminant activity exceeds the working range of the RAS instrumentation (greater than about 100,000 picocuries per gram [pCi/g] cesium-137 [^{137}Cs]).

During FY 2003, monitoring in boreholes associated with individual tanks undergoing retrieval operations was added to the work scope detailed in the original VZMP planning documents. Retrieval monitoring requirements for specific tanks are under development but include a pre-retrieval baseline measurement, monthly measurements during the retrieval operations, and monthly measurements for six months after retrieval operations cease. Both RAS and NMLS measurements are required for monthly monitoring, and monthly monitoring is supplemented by manual moisture measurements acquired by CH2M HILL Hanford Group, Inc. (CH2M HILL) personnel over limited depth intervals once or twice per week. During FY 2004, one new retrieval project (tank S-102) was initiated. Monitoring for two retrieval projects initiated in FY 2003 (tanks C-106 and S-112) continued into FY 2004. Resources (i.e., RAS) diverted from the routine monitoring to retrieval monitoring negatively impact the achievement of VZMP goals as originally set forth in 2001. Deployment of the NMLS to support retrieval operations requires an additional logging engineer and reassignment of the system from support for the RI/FS work conducted by the Department of Energy, Richland Operations Office (DOE-RL).

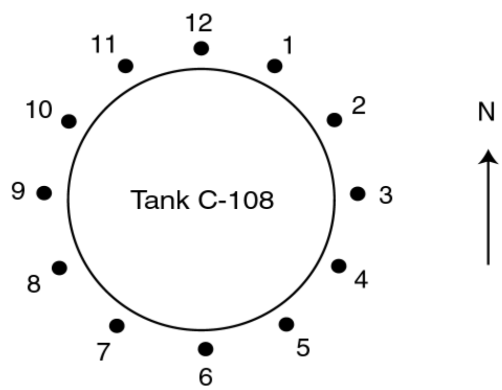
Routine quarterly reports are issued to summarize the results of monitoring activities, to provide the status of any on-going special investigations, and to provide an updated listing of borehole intervals where monitoring is planned in the coming months. The 3rd quarter monitoring report for FY 2004 was not issued due to the lack of activity during that quarter. This annual report summarizes both routine and retrieval monitoring activities for FY 2004 and includes third through fourth quarter and project-to-date results where appropriate. Retrieval monitoring is segregated from routine monitoring so that the impact to the latter can be considered.

For readers not familiar with the Hanford Tank Farms borehole-numbering scheme, the following illustration shows how to identify the location of a borehole from its identification number:

Tank Farm Numbering Scheme

A Farm	10
AX Farm	11
B Farm	20
BX Farm	21
BY Farm	22
C Farm	30
S Farm	40
SX Farm	41
T Farm	50
TX Farm	51
TY Farm	52
U Farm	60

Tank Farm Borehole Numbering Scheme



Boreholes are identified by numbers using the format FF-TT-PP, where "FF" = tank farm, "TT" = tank, and "PP" = the position around the tank in a time-clock numeral from 1 to 12 (12 = north). For example, borehole 30-08-02 is in the C Tank Farm, around tank C-108, and at approximately the 2 o'clock position.

2.0 Monitoring Results

Summaries of monitoring operations for the third and fourth quarters of FY 2004 and project-to-date are included in Tables 2-1 and 2-2, respectively.

Table 2-1. Summary of Monitoring Operations for 3rd and 4th Quarters of FY 2004

Month	April	May	June	July	August	September	Total
Routine Monitoring Events (RAS)	0	0	0	0	0	0	0
Retrieval Monitoring Events (RAS)	5	0	0	0	0	0	5
Total RAS Events	5	0	0	0	0	0	5
Total NMLS Events	7	0	0	0	0	0	7
Total RAS & NMLS Events	12	0	0	0	0	0	12
Routine Main Log Footage (RAS)	0	0	0	0	0	0	0
Routine Rerun Log Footage (RAS)	0	0	0	0	0	0	0
Retrieval Main Log Footage (RAS)	515	0	0	0	0	0	515
Retrieval Rerun Log Footage (RAS)	20	0	0	0	0	0	20
Retrieval Main Log (NMLS)	768	0	0	0	0	0	768
Retrieval Rerun Log (NMLS)	70	0	0	0	0	0	70
Total RAS Footage	535	0	0	0	0	0	535
Total NMLS Footage	838	0	0	0	0	0	838
Total RAS & NMLS Footage	1373	0	0	0	0	0	1373

Table 2-2. Summary of Monitoring Operations for FY 2004 and Project-to-Date

Quarter	1	2	3	4	FY 04	Project-to-Date Total
Routine Monitoring Events (RAS)	22	4	0	0	26	850
Retrieval Monitoring Events (RAS)	34	20	5	0	59	110
Total RAS Events	56	24	5	0	85	963
Total NMLS Events	33	21	7	0	61	88
Total RAS & NMLS Events	89	45	12	0	146	1048
Routine Main Log Footage (RAS)	1296	253	0	0	1549	47962
Routine Rerun Log Footage (RAS)	40	10	0	0	50	2278
Retrieval Main Log Footage (RAS)	3542	2063	515	0	6120	11704
Retrieval Rerun Log Footage (RAS)	90	50	20	0	160	280
Retrieval Main Log (NMLS)	3652	2266	768	0	6686	9735
Retrieval Rerun Log (NMLS)	330	210	70	0	610	880
Total RAS Footage	4968	2376	535	0	7879	62224
Total NMLS Footage	3982	2476	838	0	7296	10615
Total RAS & NMLS Footage	8950	4852	1373	0	15175	72839

Appendix A includes three tables that provide further details of boreholes monitored during FY 2004. Table A-1 presents boreholes/events for routine monitoring with the RAS, and Tables A-2 and A-3 present boreholes/events for RAS and NMLS retrieval monitoring, respectively. These tables are derived from the project's monitoring database, which is continually updated as boreholes are monitored (DOE 2003b). Boreholes are selected by a priority score (total score) that emphasizes proximity to tanks with significant drainable liquid remaining and/or the presence of contaminant plumes or where possible contaminant movement is suspected. The most significant change that occurs in the database is the monitoring frequency. Where monitoring results suggest possible contaminant movement, the monitoring frequency may be increased and depth intervals may be changed. Monitoring frequencies have also been changed to reflect the monthly monitoring requirement for retrieval operations in C and S Farms. Some lower priority boreholes are also selected for monitoring. This re-prioritization included boreholes in the vicinity of tanks being considered for closure in the near future, such as in C and S Farms.

A total of 26 routine and 59 retrieval (85) monitoring events were performed with the RAS during FY 2004. In addition, 61 moisture monitoring events were conducted in support of retrieval operations. The following sections describe the routine monitoring performed in each tank farm. In the interest of brevity, plots for boreholes where no apparent change was observed will not be included in this report. These logs are available on request. Table 2-3 lists boreholes that have shown indications of possible changes to the radionuclide contaminant profile. Boreholes that have shown changes during FY 2004 appear in bold. Appendix B contains a map of each single-shell tank farm with the locations of all boreholes used for monitoring. Each borehole location is identified by a label (borehole number) and a symbol. The symbols are used to represent the monitoring frequency of the borehole, and if any movement has been identified in a particular borehole. A black dot means the borehole has not been monitored since the SGLS baseline was performed. Boreholes that are not available for monitoring are also identified.

Table 2-3. Summary of Monitored Boreholes Indicating Radionuclide Contaminant Profile Changes

Tank Farm	Borehole Number	Radio-Nuclide	Deter-mined	Number of Events	Assessment	Assigned Frequency	Qtrly/Annual Report
BX	21-12-02	^{60}Co	9/23/03	3	Possible decrease	6 mos.	FY 2003
BX	21-27-08	$^{238}U/^{235}U$	03/13/02	5	Not confirmed	6 mos.	2nd 2002
BY	22-03-04	^{60}Co	11/15/01	4	Not confirmed	6 mos.	1st 2002
BY	22-07-02	^{60}Co	11/29/01	3	Not confirmed	6 mos.	1st 2002
BY	22-07-05	^{60}Co	12/12/01	3	Not confirmed	6 mos.	1st 2002
BY	22-08-05	^{60}Co	03/30/99	4	Not confirmed	6 mos.	1st 2002
C	**30-06-10**	**^{60}Co**	**03/03/97**	**8**	**Definite change**	**1 mos.**	**FY 2004**
C	**30-08-02**	**^{60}Co**	**09/11/02**	**8**	**Definite increase**	**1 mos.**	**FY 2004**
C	30-08-03	?	1/21/03	3	Not confirmed	3 mos.	FY 2003
S	**40-02-03**	**^{137}Cs**	**7/9/03**	**1**	**Definite increase**	**1 mos.**	**FY 2004**
SX	41-02-02	$^{137}Cs/^{90}Sr$	09/07/01	5	Not confirmed	6 mos.	FY 2001
SX	41-10-01	^{137}Cs	2/11/03	4	Possible increase	6 mos.	FY 2003
SX	41-15-07	^{137}Cs	2/12/03	2	Not confirmed	6 mos.	FY 2003
T	50-01-09	^{60}Co	07/30/01	5	Not confirmed	6 mos.	FY 2001
T	50-02-05	^{137}Cs	5/19/03	4	Not confirmed	6 mos.	FY 2003
T	50-06-02	$^{60}Co/^{154}Eu$	07/18/01	5	Not confirmed	6 mos.	FY 2001
T	50-06-03	^{60}Co	07/18/01	5	Not confirmed	6 mos.	FY 2001
T	50-06-18	^{60}Co	09/03/02	5	Possible increase	3 mos.	FY 2002
T	50-04-10	^{60}Co	01/28/02	5	Possible confirmation	3 mos.	2nd 2002
T	50-09-01	$^{60}Co/^{154}Eu$	07/23/01	5	Not confirmed	6 mos.	FY 2001
T	50-09-02	^{60}Co	01/08/02	3	Not confirmed	12 mos.	2nd 2002
T	50-09-10	$^{60}Co/^{154}Eu$	07/23/01	5	Not confirmed	6 mos.	FY 2001
TX	51-03-11	^{60}Co	05/20/02	2	Possible increase	6 mos.	3rd 2002
TY	52-03-06	^{137}Cs	05/02/02	5	Definite change	3 mos.	3rd 2002
TY	52-06-05	^{60}Co	05/14/02	3	Possible increase	3 mos.	3rd 2002
TY	52-06-07	^{60}Co	5/22/03	2	Not confirmed	12 mos.	FY 2003
U	60-04-08	$^{238}U/^{235}U$	07/16/01	8	Not confirmed	6 mos.	FY 2001
U	60-05-05	$^{238}U/^{235}U$	08/27/02	5	Possible increase	6 mos.	FY 2002
U	60-07-01	$^{238}U/^{235}U$	07/12/01	8	Not confirmed	6 mos.	FY 2001

2.1 A Tank Farm

Routine monitoring was not performed in A Tank Farm during FY 2004.

2.2 AX Tank Farm

Routine monitoring was not performed in AX Tank Farm during FY 2004.

2.3 B Tank Farm

Routine monitoring was not performed in B Tank Farm during FY 2004.

2.4 BX Tank Farm

A total of 5 boreholes located around tanks BX-103, -107, and -110 were monitored during FY 2004. Monitoring events in these boreholes during FY 2004 did not provide evidence of contaminant movement. Borehole 21-10-05 should be logged in the near future with the HRLS to assess the stability of contaminants in the zone of high gamma flux.

2.5 BY Tank Farm

A total of 10 boreholes located around tanks BY-103, -105, and -106 were monitored during FY 2004. Borehole 22-03-04 showed a possible increase of cobalt-60 (^{60}Co) between 77 and 82 ft during the initial RAS monitoring event on 11/15/01. Three subsequent monitoring events in this borehole have not shown any further increases. Monitoring events in the other nine boreholes visited in BY Farm during FY 2004 did not provide evidence of contaminant movement.

2.6 C Tank Farm

A total of 17 boreholes located around tanks C-104, -105, -106, -108, and -109 were monitored during FY 2004. Six of these boreholes, 30-04-01, 30-04-04, 30-04-05, 30-05-06, 30-05-09, and 30-08-03 were not associated with a waste retrieval project. The boreholes located near tanks C-104 and -105 were monitored to check for contaminant movement in the vicinity of the tank C-105 characterization drilling. None of these boreholes showed evidence of contaminant movement.

Boreholes associated with tank C-106 were monitored several times during FY 2004 in support of the C-106 Waste Retrieval Project. These boreholes were also logged several times with the NMLS. This work is discussed in detail in Section 3.1, “Tank C-106 Retrieval Monitoring.”

A possible ^{60}Co increase was identified in borehole 30-06-10 between 124 and 126 ft on 4/23/02 with the RAS. Monitoring events conducted in this borehole during FY 2004 showed no further evidence of movement. SGLS logging performed on 2/27/04 confirmed the ^{60}Co movement and showed the leading edge to be at or beyond the bottom of the borehole at 129 ft. Earlier SGLS logging identified the ^{60}Co at 116.5 ft on 1/29/97 and at 123.5 ft on 3/3/99. A composite log plot of this borehole is included in Appendix C.

A definite change in ^{60}Co concentrations was discovered in borehole 30-08-02 on 9/11/02 between 50 and 61 ft. Subsequent monitoring events during FY 2004 have shown downward movement of ^{60}Co through this interval. SGLS logging performed in this borehole on 2/23/04 confirmed an increase in ^{60}Co concentrations between 47 and 76 ft. A composite log plot of this borehole is included in Appendix C.

One new borehole (C4297) was logged with the SGLS and NMLS at request of CH2M HILL in support of the tank C-105 characterization drilling. Borehole 30-05-07 was also logged with the HRLS to support this project. This work is discussed in detail in Section 4.1.

2.7 S Tank Farm

A total of 15 boreholes located around tanks S-102, -103, -105, -109, -111, and -112 were monitored during FY 2004. Only two of these boreholes, 40-05-08 and 40-05-10, were not associated with a waste retrieval project. Neither borehole provided evidence of contaminant movement.

Boreholes associated with tank S-112 were monitored several times during FY 2004 in support of the S-112 Waste Retrieval Project. These boreholes were also logged several times with the NMLS. This work is discussed in detail in Section 3.2, "Tank S-112 Retrieval Monitoring."

Boreholes located around tank S-102 were monitored in preparation for the S-102 Waste Retrieval Project. These boreholes were also logged with the NMLS. This work is discussed in detail in Section 3.3, "Tank S-102 Retrieval Monitoring."

An apparent increase in ^{137}Cs concentration was observed in borehole 40-02-03 between 44 and 47 ft on 7/8/03. This borehole was logged with the SGLS and NMLS on 4/7/04 and with the HRLS on 4/12/04 as part of the pre-retrieval logging for the tank S-102 Waste Retrieval Project. The SGLS log confirmed an increase in ^{137}Cs concentrations between 44.5 and 48 ft. A composite log of this borehole is included in Appendix C.

2.8 SX Tank Farm

Routine monitoring was not performed in SX Tank Farm during FY 2004.

2.9 T Tank Farm

Routine monitoring was not performed in T Tank Farm during FY 2004.

2.10 TX Tank Farm

Routine monitoring was not performed in TX Tank Farm during FY 2004.

2.11 TY Tank Farm

Routine monitoring was not performed in TY Tank Farm during FY 2004.

2.12 U Tank Farm

Routine monitoring was not performed in U Tank Farm during FY 2004.

3.0 Retrieval Monitoring

3.1 Tank C-106 Retrieval Monitoring

The *Process Control Plan for Tank 241-C-106 Acid Dissolution* (Reynolds 2003) specified retrieval monitoring is conducted monthly: *"The wells will be monitored monthly (or before initial acid addition, monthly during retrieval, and after retrieval) to detect any changes in the radiation or moisture profiles of the soil."* Additional manual measurements are to be performed by operations personnel within specific zones at a frequency of two times per week.

RAS retrieval monitoring started in January 2003; seven monitoring events were conducted by the end of FY 2004. Beginning in April 2003, six NMLS logs had been acquired through the end of FY 2004. SGLS logging was performed in boreholes 30-06-02, -04, -09, -10, and 30-08-02 during late February and early March 2004 to investigate regions of apparent moisture increases. This logging was performed as a result of the "Problem Evaluation Request" (PER) initiated on December 3, 2003 in response to the apparent increase in moisture (~1%) in the vadose zone beneath tank C-106. The only increases in gamma activity identified during this logging occurred in boreholes 30-08-02 and 30-06-10. This zone of contaminant movement had been identified prior to the start of retrieval activities and therefore does not appear to be related to the retrieval process. Appendix D includes a summary plot of data acquired around tank C-106. These data include SGLS baseline measurements (^{40}K, ^{137}Cs, ^{60}Co), six moisture measurements, and the RAS measurements acquired through the end of FY 2004.

A letter report "241-C-106 Tank Waste Retrieval Project Interim Report of Drywell Monitoring Data" was issued in March 2004 (Appendix D). This report discusses all of the monitoring data collected to date for the 241-C-106 Tank Waste Retrieval Project. Log plots for each drywell are also included in this report.

No monitoring activities have been performed in C Farm since March 2004 because of access restrictions resulting from health and safety issues in tank farms.

3.2 Tank S-112 Retrieval Monitoring

The *Process Control Plan for Saltcake Dissolution Retrieval Demonstration in Tank 241-S-112* (Barton 2003) specified retrieval monitoring requirements. *"A baseline profile will be taken prior to retrieval operations, and subsequent monitoring results will be compared with that baseline profile. Moisture monitoring using the truck-mounted system will be done before beginning, at the end, and whenever there is a shutdown of retrieval operations greater than 4 weeks. An initial baseline will be established by deploying calibrated gamma and neutron moisture probes over the full depth of each drywell. During waste retrieval operations, the truck-mounted systems will be supplemented by the use of manually deployed moisture gages at least once a week while actively retrieving the waste at depths corresponding to moist layers at or below the floor of the tank."*

The baseline moisture measurements were acquired during August 2003. Three additional moisture logging events (October, November, and February) were performed in the eight boreholes surrounding tank S-112. A fourth moisture logging event was performed in boreholes 40-11-08 and 40-12-04 in April 2004. This logging event was cut short by the fresh air entry requirement and not completed. No additional moisture logging has taken place since this requirement was initiated. There were minor increases identified during the later moisture logging events, but these may be attributed to seasonal fluctuations. Three RAS measurements (October, November, and February) were acquired to support retrieval operations during FY 2004. No changes in activity were observed between the two RAS measurements or since the baseline spectral gamma data acquired in 1996.

Log plots showing the baseline SGLS data, RAS data, and moisture data for each borehole are included in Appendix E.

Additional RAS and NMLS monitoring is planned for this retrieval project as soon as the personnel have met the appropriate entry requirements to enter this farm on fresh air.

3.3 Tank S-102 Retrieval Monitoring

In anticipation of future tank S-102 (S Farm) retrieval activities, RAS monitoring of the boreholes around tank S-102 began in September of 2002. An additional RAS monitoring event was performed in July 2003. The RAS collected monitoring data from five of the nine boreholes in April of 2004. The other four boreholes were not monitored because this work was halted due to the fresh air entry requirement imposed on approximately April 16, 2004. An increase in ^{137}Cs concentration was discovered in one borehole 40-02-03 between 44 and 47 ft during the first RAS monitoring event in July 2003. This increase was first reported in the *Hanford Tank Farms Vadose Zone, Annual Monitoring Report for Fiscal Year 2003* (DOE 2003a).

Baseline moisture logging was performed in 8 of the 9 boreholes surrounding this tank. Moisture logging was not performed in borehole 40-02-04, because surface equipment prevented access to this borehole. SGLS logging was performed in selected intervals from three of these boreholes (40-02-03, 40-02-07, and 40-02-08). The SGLS logging confirmed the ^{137}Cs increase in borehole 40-02-03. High rate logging was also performed in borehole 40-02-03. Log plots of the data collected above were provided to CH2M HILL via email on April 12, 2004. These log plots are included in Appendix F.

Additional RAS and NMLS monitoring is planned for this retrieval project as soon as the personnel have met the appropriate entry requirements to enter this farm on fresh air.

4.0 Special Projects

4.1 Tank C-105 Characterization Drilling

One new borehole (C4297) was drilled in C Farm southwest of tank C-105. Both casing strings of this borehole were logged with the SGLS and NMLS logging systems. Log plots showing the results of the moisture measurement plotted with the SGLS data (^{40}K, ^{238}U, ^{232}Th, ^{137}Cs, ^{60}Co, and ^{154}Eu) are included in Appendix G.

5.0 Operational Issues

During the third quarter of FY 2004, an average of approximately 0.1 boreholes were monitored per working day with the RAS. This rate dropped to zero during the fourth quarter of FY 2004. **Note: This analysis does not segregate routine monitoring from retrieval monitoring with the RAS or include NMLS logging**. This rate incorporates all operational aspects of monitoring, including both scheduled and unscheduled down time for maintenance, operator support, security, etc. The rate of monitoring achieved during this fiscal year decreased each successive quarter from 1.0 during the 1st quarter to 0.0 during the 4th quarter. The project goal was to achieve an average of 3 boreholes per day.

The project experienced between 27 and 62 days of down time each quarter during FY 2004. The majority of this down time was due to the fresh air entry requirement initiated on approximately April 16, 2004. This requirement doubles the manpower needed to perform this activity. The RAS project often had lower priority than other Tank Farms projects when manpower resources were assigned each day; therefore, when resources are required for higher priority tasks the RAS operators are diverted to these other tasks.

Tables 5-1 and 5-2 include summaries of production and operational issues, respectively, that affect monitoring production.

Table 5-1. Summary of Monitoring Production (Project-to-Date)

Quarter	Total Work Days	Total Days Down	Total Monitoring Events	Boreholes Monitored per Day
4th of FY01	56	29.3	84	1.5
1st of FY02	56	35.2	54	1.0
2nd of FY02	55	34.1	74	1.3
3rd of FY02	59	21.1	113	1.9
4th of FY02	66	27.6	144	2.2
1st of FY03	56	34.7	72	1.3
2nd of FY03	55	22.5	97	1.8
3rd of FY03	58	25.0	105	1.8
4th of FY03	63	22.6	103	1.6
1st of FY04	56	27.4	56	1.0
2nd of FY04	55	42.1	24	0.4
3rd of FY04	63	59.9	5	0.1
4th of FY04	62	62.0	0	0.0
FY04Total	236	191.4	85	0.4
Cumulative Total	760	443.5	931	1.2
Average/Quarter	58.5	34.1	71.6	1.2

Table 5-2. Summary of Operational Down Time

Quarter	Equipment/ Truck Problems/Calibration (hrs)	No HPT/ Operator Support (hrs)	Security Measures (hrs)	No Charge Code or Administrative (hrs)	Moving Truck (hrs)	Weather (hrs)	Misc. / Fresh Air Requirement (hrs)	Total Down Time (hrs)
4th of FY01	64	130	20	27	20	3	0	264
1st of FY02	107	84	51	44	14	13	4	317
2nd of FY02	143	40	24	58	9	18	15	307
3rd of FY02	31	62	0	36	27	8	26	190
4th of FY02	81	122	0	0	37	0	8	248
1st of FY03	71	107	0	18	18	0	98	312
2nd of FY03	62	126	0	0	10	0	0	198
3rd of FY03	51	149	0	0	12	0	13	225
4th of FY03	45	136	0	0	16	6	0	203
1st of FY04	6	198	0	0	12	22	9	247
2nd of FY04	178	95	0	0	6	98	2	379
3rd of FY04	26	18	0	9	2	0	424	479
4th of FY04	0	0	0	0	0	0	513	513
FY04Total	210	311	0	9	20	120	948	1618
Cumulative Total	865	1267	95	192	183	168	1112	3882
Average/Quarter	66.5	97.5	7.3	14.8	14.1	12.9	85.5	298.6

6.0 Summary

Twenty-six routine and 59 retrieval monitoring events were performed with the RAS in FY 2004. A total of 931 routine monitoring events (110 retrieval events) have been performed since the beginning of the project in June 2001. An additional 89 events (62 events in FY 2004) with the NMLS were provided. Spectral gamma logs were collected from 9 boreholes and high rate spectral logs were collected from 2 boreholes in support of retrieval projects this fiscal year. To date, the high priority boreholes in all tank farms have been monitored at least once, but the recommended monitoring frequency has not been met for these boreholes. There are 310 lower priority boreholes within the single-shell tank farms that have yet to be monitored.

Evidence of possible contaminant movement has been detected in 29 boreholes in nine tank farms. Of these 29 boreholes, data collected from two boreholes indicate movement to a degree that can be confirmed over a short time interval. Of the remaining 27 boreholes it is likely that the elapsed time between monitoring events is not sufficient to detect subtle changes in contaminant profile, suggesting relatively slow movement of contaminants in the vadose zone. In general, intervals where discernable movement of contaminants through the vadose zone is occurring within short periods of time (e.g., less than 1.5 years) appear to be very limited. This finding, corroborated with continued measurements, will be useful to select appropriate remedial actions for tank farm closure and/or removal of contaminated soil.

7.0 Future Monitoring Operations

Due to regulatory commitments and operating limitations in Tank Farms, DOE-ORP and their contractor have refocused the monitoring effort from routine monitoring to retrieval monitoring. Therefore, the monitoring schedule for the RAS will be built on the monitoring requirements associated with the various retrieval projects. This schedule will also apply to the NMLS logging required for the retrieval projects. Appendix H provides a summary of boreholes scheduled for retrieval monitoring through the end of the first quarter of FY 2005.

A new portable logging system capable of recording gross gamma and moisture measurements simultaneously has been ordered and should be ready to begin monitoring in support of the retrieval projects during the second quarter of FY 2005. This system will take the place of both the RAS and NMLS and will be operated by the HAMTAC operators. It is planned that the RAS be left intact for future routine monitoring.

High rate logging has not been performed in the tank farms since FY 2002. Because the areas that exhibit high activity contain the greatest contaminant inventory in the farms, it is essential to monitor these areas for changes on a more frequent basis. Approximately 25 boreholes require high rate logging, which would require a level of effort of approximately one month.

8.0 Recommendations

The monitoring program in the single-shell tank farms was initiated in 2000 after the initial success of the Vadose Zone Characterization Project. Experience gained from the past baseline characterization efforts and current activities during this period suggest significant changes in the monitoring of tank farms. Based upon these findings, significant issues and recommendations for improvement are discussed below.

8.1 Routine Monitoring Program

Vadose zone monitoring activities in the single-shell tank farms are performed under the control of the ORP tank farm contractor with oversight and technical input from Stoller. In the past six months, there has been effectively no routine monitoring in the single-shell tank farms. Routine monitoring operations are dependent upon personnel employed by the tank farms contractor, whose primary goal is waste retrieval.

The primary reasons routine monitoring activities have been discontinued are the prioritization of resources and personnel to retrieval operations and tank farm access restrictions arising from health and safety concerns.

Comparison of ongoing monitoring data with baseline and historical data is important in unraveling the complex leak history in the single-shell tank farms, assessing stability of individual contaminant plumes, and determining the suitability of individual tanks for sluicing operations. In the vicinity of tank C-106, for example, routine monitoring data have detected continued downward movement in a ^{60}Co plume on the north side of the tank. Baseline data indicate that the plume likely originates between tanks C-108 and C-109. The plume appears to be moving downward and to the east in the region between tanks C-109 and C-106. Routine monitoring activities detected this movement well before retrieval operations were initiated in tank C-106 and thus established that the observed increases in subsurface activity were not related to tank C-106 retrieval operations. In the absence of a routine monitoring program, it is possible that observed changes in the lower extent of the plume would have been attributed to the retrieval operation, resulting in an erroneous determination that a leak had occurred. Clearly defined and uniformly implemented requirements for routine and tank retrieval leak detection will improve credibility and the potential acceptability of future Hanford Remedial Actions.

It is strongly recommended that routine monitoring activities be reemphasized and performed where the monitoring activity is given a high priority in resource allocation at Tank Farms.

8.2 Centralize Responsibility for Geophysical Monitoring Technology, Equipment, and Data Interpretation

New low-cost portable logging systems can be used for the monthly monitoring events now performed by the RAS and SGLS. These systems can also be used for more frequent measurements, replacing the existing manual moisture monitoring units. This improves overall data comparability and reduces the potential for false detections based on increase in observed moisture. Under the current monitoring approach, any increase in moisture observed with the manual moisture gauges results in an immediate need for gamma logging to determine if a leak has in fact occurred. In addition, manual moisture monitoring is subject to data transcription errors and to errors associated with slight variations in depth between successive measurements. In many cases, a specific monitoring point is selected at a peak in the neutron moisture log. When subsequent manual moisture measurements are made, slight variations in detector depth may appear as changes in moisture content. The portable logging equipment will provide combined and continuous neutron moisture and gamma activity measurements over a specified depth interval with electronic data recording, eliminating transcription errors and providing a continuous profile that allows depth errors to be more readily recognized. New technologies such as High Resolution Resistivity (HRR) are being investigated without benefit of baseline comparison plans or integration into the ongoing monitoring or retrieval monitoring programs.

RAS and NMLS data are currently processed and evaluated by Stoller, while the manual moisture measurements are reported to CH2M HILL. This creates a situation wherein discrepancies between the two data sets may not be immediately recognized.

The designation of a single responsible contractor for geophysical logging to collect, evaluate, and manage borehole and vadose zone monitoring technological needs, equipment, and measurement data would significantly improve the effectiveness and quality of Hanford geophysical data collection and interpretation.

References

Barton, W.B., 2003. *Process Control Plan for Saltcake Dissolution Retrieval Demonstration in Tank 241-S-112*, RPP-15085, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

Reynolds, D.A., 2003. *Process Control Plan for Tank 241-C-106 Acid Dissolution*, RPP-16462, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

U.S. Department of Energy (DOE), 2003b. *Hanford Tank Farms Vadose Zone Monitoring Project, Annual Monitoring Report for Fiscal Year 2003*, GJO-2004-554-TAC, Grand Junction Office, Grand Junction, Colorado.

U.S. Department of Energy (DOE), 2003b. *Hanford Tank Farms Vadose Zone Monitoring Project, Baseline Monitoring Plan*, GJO-HGLP 1.8.1, Revision 0, Grand Junction Office, Grand Junction, Colorado.

Appendix A
Boreholes Monitored During FY 2004

Table A-1. Routine Boreholes Monitored During FY 2004

Borehole Number	Tank	Top	Bottom	Footage	Rerun Footage	Log Freq. (days)	Next Log Date	Last Event	Total FY 2004 Events	Total Events (to date)	Comment
30-08-02	C-108	30	99	69		36	03/17/04	02/17/04	1	8	Def. change Co-60 49-75 ft, down, C-106 Retrieval
30-09-06	C-109	30	98	68		36	03/20/04	02/20/04	1	7	No apparent change, C-106 Retrieval
30-09-07	C-109	30	121	91		36	03/17/04	02/17/04	1	7	No apparent change, C-106 Retrieval
30-04-04	C-104	30	98	68	10	1800	01/07/09	02/03/04	1	1	No apparent change
30-04-05	C-104	30	98	68		1800	01/07/09	02/03/04	1	1	No apparent change
30-05-06	C-105	0	57	57		1800	01/01/09	01/28/04	1	1	No apparent change
30-05-09	C-105	30	90	60		1800	12/30/08	01/26/04	1	1	No apparent change
30-04-01	C-104	0	48	48		1800	11/20/08	12/17/03	1	1	No apparent change
22-05-01	BY-105	40	98	58	10	360	11/06/04	11/12/03	1	3	No apparent change
22-05-09	BY-105	40	98	58		360	11/06/04	11/12/03	1	3	No apparent change
22-03-07	BY-103	40	98	58		360	11/04/04	11/10/03	1	3	No apparent change
22-03-08	BY-103	40	99	59		360	11/04/04	11/10/03	1	3	No apparent change
22-03-09	BY-103	30	97	67		360	11/04/04	11/10/03	1	3	No apparent change
22-00-03	BY-103	40	145	105		360	10/31/04	11/06/03	1	3	No apparent change
22-03-04	BY-103	40	100	60		180	05/04/04	11/06/03	1	4	Possible change 77-82 ft not confirmed
22-03-06	BY-103	40	99	59		360	10/31/04	11/06/03	1	3	No apparent change
22-00-02	BY-103	40	98	58		180	05/03/04	11/05/03	1	4	No apparent change
22-06-01	BY-106	40	80	40		360	10/29/04	11/04/03	1	3	No apparent change
30-08-03	C-108	30	50	20	10	180	04/25/04	10/28/03	1	3	No apparent change
40-05-10	S-105	40	80	40	10	1800	09/11/08	10/08/03	1	1	No apparent change
21-10-05	BX-110	47	98	56		360	09/30/04	10/06/03	1	3	Requires HRLS
40-05-08	S-105	40	80	40		1800	09/09/08	10/06/03	1	1	No apparent change
21-10-03	BX-110	35	99	64		360	09/26/04	10/02/03	1	2	No apparent change
21-03-03	BX-103	35	90	55	10	180	03/29/04	10/01/03	1	5	No apparent change
21-04-08	BX-107	35	99	64		360	09/25/04	10/01/03	1	3	No apparent change
21-07-03	BX-107	35	99	64		360	09/25/04	10/01/03	1	3	No apparent change
			Total Routine Monitoring Events During FY 2004 =						**26**		

Note: Boreholes 30-08-02, 30-09-06, and 30-09-07 were reclassified as retrieval boreholes after the first monitoring event during FY 2004.

Table A-2. Retrieval Boreholes Monitored During FY 2004

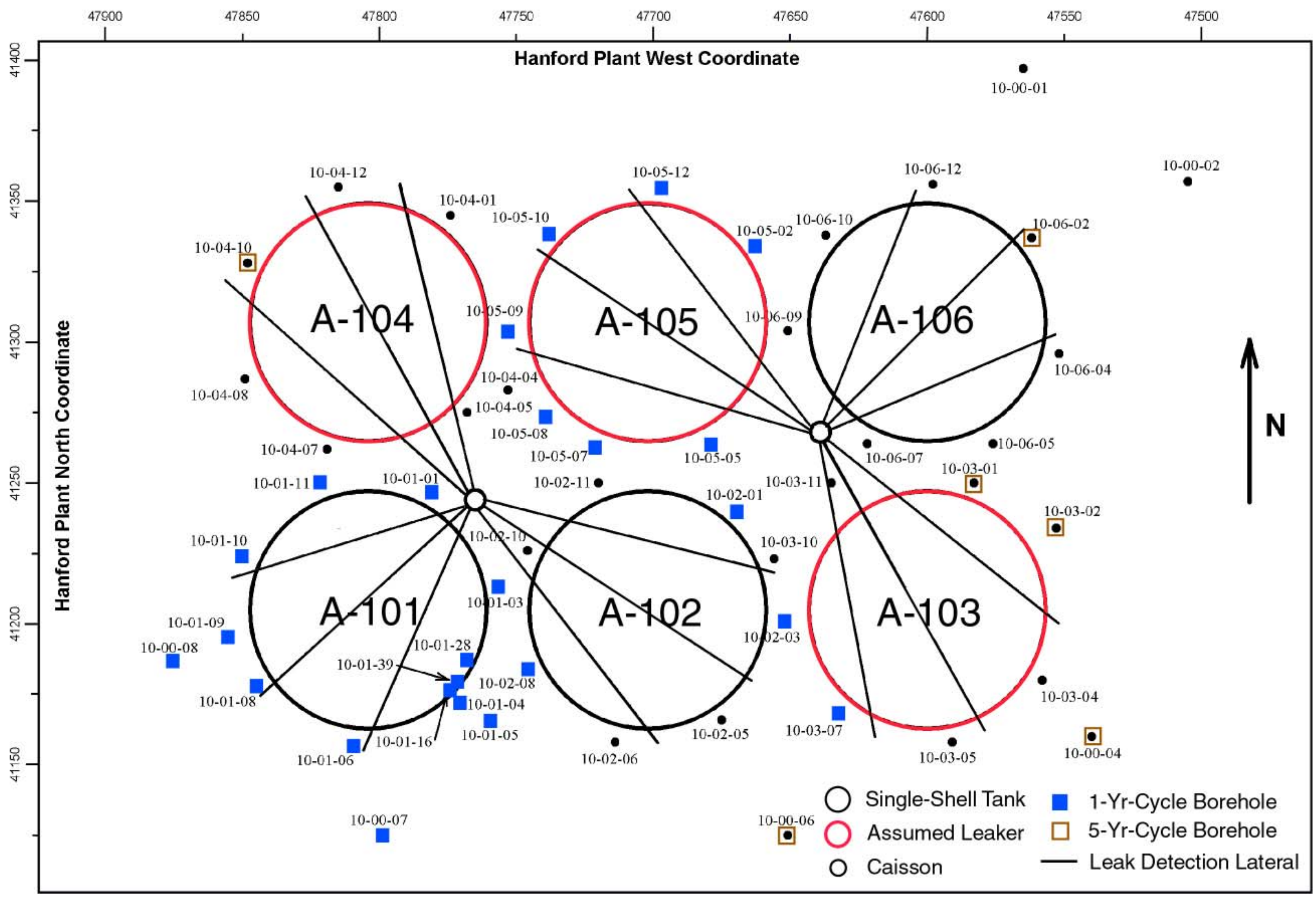
Borehole Number	Tank	Top	Bottom	Footage	Rerun Footage	Next Log Date	RAS Event A	RAS Event B	RAS Event C	RAS Event D	RAS Event E	RAS Event F	Ras Event G	Ras Event H	Total FY 2004 Events	Total Events (to date)	Comment
30-00-01	C-106	0	65	65		04/06/04	04/24/02	01/16/03	04/28/03	07/22/03	09/15/03	11/03/03	12/02/03	03/01/04	3	8	No apparent change, C-106 Retrieval
30-05-02	C-105	5	127	122	30	03/26/04	04/22/02	01/29/03	04/29/03	07/23/03	09/17/03	10/23/03	12/15/03	02/19/04	3	8	No apparent change, C-106 Retrieval
30-06-02	C-106	0	122	122		03/30/04	01/27/03	04/28/03	07/21/03	09/16/03	10/21/03	01/26/04	02/23/04		3	7	No apparent change, C-106 Retrieval
30-06-03	C-106	0	98	98		03/30/04	01/23/03	04/28/03	07/21/03	09/16/03	10/22/03	12/02/03	02/23/04		3	7	No apparent change, C-106 Retrieval
30-06-04	C-106	0	129	129		04/01/04	09/11/02	01/27/03	04/29/03	07/23/03	09/17/03	10/31/03	12/22/03	02/25/04	3	8	No apparent change, C-106 Retrieval
30-06-09	C-106	5	98	93	30	03/26/04	04/22/02	01/22/03	04/22/03	07/22/03	09/10/03	10/23/03	12/12/03	02/19/04	3	8	No apparent change, C-106 Retrieval
30-06-10	C-106	0	128	128		04/02/04	04/23/02	01/23/03	04/22/03	07/22/03	09/08/03	11/03/03	12/22/03	02/26/04	3	8	Possible change 124-126 ft Co-60, C-106 Retrieval
30-06-12	C-106	0	98	98		04/06/04	04/24/02	01/24/03	04/29/03	07/22/03	09/11/03	10/22/03	12/08/03	03/01/04	3	8	No apparent change, C-106 Retrieval
30-08-02	C-108	30	99	69		03/17/04	09/11/02	09/12/02	01/21/03	05/05/03	07/30/03	11/04/03	12/17/03	02/17/04	2	8	Def. change Co-60 49-75 ft, down, C-106 Retrieval
30-09-06	C-109	30	98	68		03/20/04	04/23/02	01/29/03	05/05/03	07/30/03	10/31/03	12/12/03	02/20/04		2	7	No apparent change, C-106 Retrieval
30-09-07	C-109	30	121	91		03/17/04	09/11/02	01/16/03	05/02/03	07/30/03	10/29/03	12/15/03	02/17/04		2	7	No apparent change, C-106 Retrieval
40-09-06	S-109	0	98	98		03/12/04	06/05/02	03/11/03	08/27/03	10/15/03	11/24/03	02/05/04			3	6	No apparent change; S-112 Retrieval
40-11-08	S-111	0	97	97	20	03/11/04	06/03/02	10/17/03	11/25/03	02/04/04					3	4	No apparent change, S-112 Retrieval
40-11-09	S-111	0	98	98	10	03/12/04	06/05/02	06/18/03	10/16/03	12/01/03	02/05/04				3	5	No apparent change, S-112 Retrieval
40-12-02	S-112	0	99	99		03/12/04	06/05/02	03/12/03	08/27/03	10/16/03	11/24/03	02/05/04			3	6	No apparent change; S-112 Retrieval
40-12-04	S-112	0	126	126		03/11/04	06/04/02	03/10/03	08/22/03	10/09/03	11/25/03	02/04/04			3	6	No apparent change; S-112 Retrieval
40-12-06	S-112	0	144	144	30	03/16/04	06/04/02	03/10/03	08/21/03	10/14/03	11/19/03	02/09/04			3	6	No apparent change; S-112 Retrieval
40-12-07	S-112	0	98	98		03/13/04	06/04/02	03/11/03	08/26/03	10/08/03	11/19/03	02/06/04			3	6	No apparent change; S-112 Retrieval
40-12-09	S-112	0	98	98		03/13/04	06/05/02	03/11/03	08/27/03	10/14/03	11/17/03	02/06/04			3	6	No apparent change; S-112 Retrieval
40-03-03	S-103	0	122	122	10	05/21/04	09/16/02	04/15/04							1	2	No apparent change, S-102 Retrieval
40-02-08	S-102	0	99	99	10	05/20/04	09/17/02	07/07/03	04/14/04						1	3	No apparent change, S-102 Retrieval
40-02-07	S-102	0	95	95		05/19/04	09/17/02	07/07/03	04/13/04						1	3	No apparent change, S-102 Retrieval
40-02-10	S-102	0	99	99		05/19/04	09/17/02	07/01/03	04/13/04						1	3	No apparent change, S-102 Retrieval
40-02-11	S-102	0	100	100		05/18/04	09/19/02	07/02/03	04/12/04						1	3	No apparent change, S-102 Retrieval
										Total Retrieval Monitoring Events FY 2004 =					**59**		

Note: Boreholes 30-08-02, 30-09-06, and 30-09-07 were counted as routine monitoring boreholes during the first logging event of FY 2004.

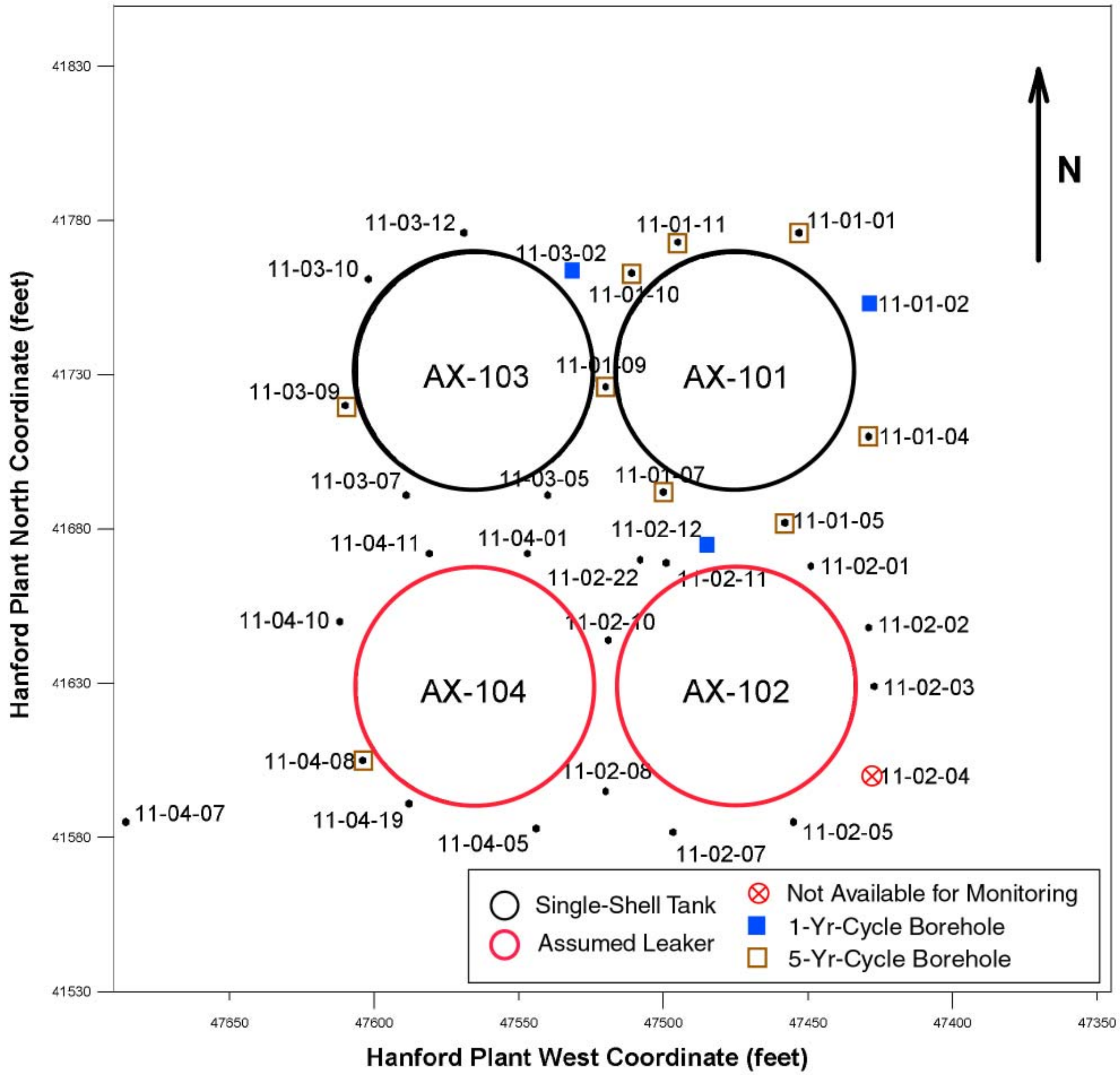
Table A-3. Retrieval Boreholes Logged with the Neutron Moisture Logging System During FY 2004

Borehole Number	Tank	Top	Bottom	Footage	Rerun Footage	Next Event	NMLS Event 1	NMLS Event 2	NMLS Event 3	NMLS Event 4	NMLS Event 5	NMLS Event 6	Total FY 2004 Events	Total Events (to date)	Comment
30-05-02	C-105	0	127	127	30	03/12/04	04/28/03	07/21/03	09/08/03	10/22/03	12/02/03	02/11/04	3	6	Possible increase 42-70 ft
30-06-02	C-106	0	122	122	30	03/19/04	04/30/03	07/22/03	09/10/03	10/20/03	12/04/03	02/18/04	3	6	Possible increase 56-76 ft
30-06-03	C-106	0	98	98	30	03/18/04	04/30/03	07/22/03	09/09/03	10/21/03	12/04/03	02/17/04	3	6	Possible increase 57-68 ft
30-06-04	C-106	0	129	129	30	03/31/04	04/30/03	07/23/03	09/11/03	10/23/03	12/10/03	03/01/04	3	6	Possible increase 45-53 ft
30-06-09	C-106	0	98	98	30	03/13/04	04/28/03	07/21/03	09/08/03	10/22/03	12/02/03	02/12/04	3	6	Possible increase 50-72 ft
30-06-10	C-106	0	128	128	30	03/18/04	04/29/03	07/22/03	09/04/03	10/21/03	12/03/03	02/17/04	3	6	Possible increase 42-58 ft
30-06-12	C-106	0	98	98	30	03/19/04	04/29/03	07/22/03	09/09/03	10/21/03	12/04/03	02/18/04	3	6	Possible increase 50-60 ft
30-08-02	C-108	0	99	99	20	03/21/04	12/09/03	02/20/04					2	2	No apparent change
30-09-06	C-109	0	98	98	20	03/13/04	12/08/03	02/12/04					2	2	No apparent change
30-09-07	C-109	0	121	121	20	03/13/04	12/08/03	02/12/04					2	2	No apparent change
40-09-06	S-109	0	98	98	30	03/10/04	08/27/03	10/09/03	11/25/03	02/09/04			3	4	Possible increase 40-50 ft
40-11-08	S-111	0	96	96	40	05/14/04	10/14/03	11/26/03	02/09/04	04/14/04			4	4	None
40-11-09	S-111	0	98	98	30	03/07/04	10/14/03	11/25/03	02/06/04				3	3	Possible increase 23-33 ft
40-12-02	S-112	0	99	99	30	03/07/04	08/26/03	10/08/03	11/25/03	02/06/04			3	4	Possible increase 32-47 ft
40-12-04	S-112	0	126	126	40	05/14/04	08/27/03	10/14/03	11/26/03	02/09/04	04/14/04		4	5	Possible increase 53-55 ft
40-12-06	S-112	0	144	144	30	03/11/04	08/26/03	10/09/03	11/24/03	02/10/04			3	4	Possible increase 35-49 ft
40-12-07	S-112	0	96	96	30	03/11/04	08/25/03	10/08/03	11/24/03	02/10/04			3	4	Possible increase 23-43 ft
40-12-09	S-112	0	99	99	30	03/10/04	08/26/03	10/08/03	11/24/03	02/09/04			3	4	Possible increase 37-50 ft
40-02-05	S-102	0	97	97	10	04/24/04	03/25/04						1	1	Only one event, no comparison
40-02-11	S-102	0	100	100	10	04/24/04	03/25/04						1	1	Only one event, no comparison
40-02-07	S-102	0	95	95	10	04/30/04	03/31/04						1	1	Only one event, no comparison
40-02-08	S-102	0	100	100	10	05/06/04	04/06/04						1	1	Only one event, no comparison
40-02-10	S-102	0	99	99	10	05/06/04	04/06/04						1	1	Only one event, no comparison
40-02-03	S-102	0	98	98	10	05/07/04	04/07/04						1	1	Only one event, no comparison
40-02-01	S-102	0	128	128	10	05/08/04	04/08/04						1	1	Only one event, no comparison
40-03-03	S-103	0	122	122	10	05/08/04	04/08/04						1	1	Only one event, no comparison
								Total Retrieval Moisture Logging Events FY 2004 =					**61**		

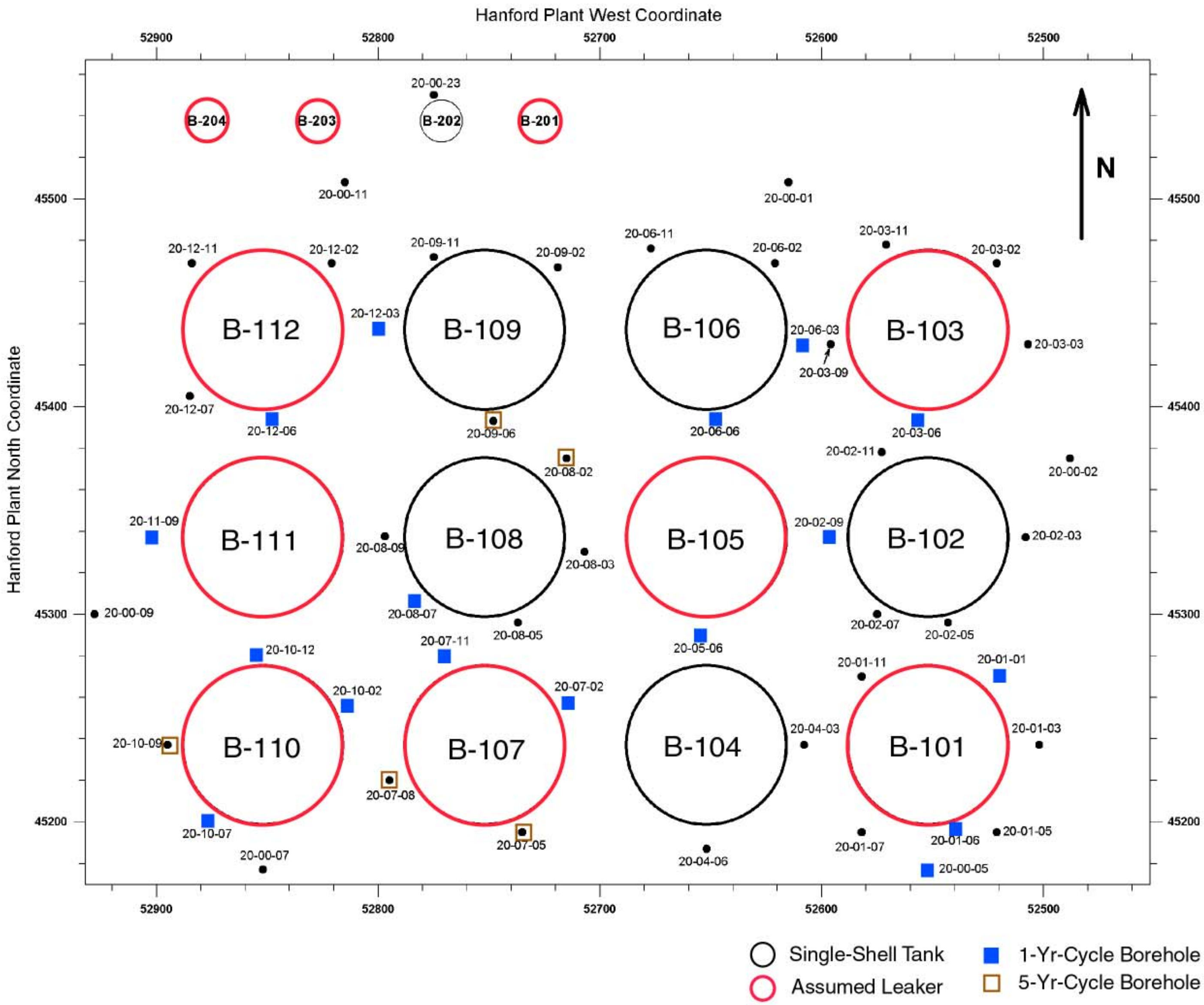
Appendix B
Tank Farm Maps with Monitoring Borehole Locations and Status

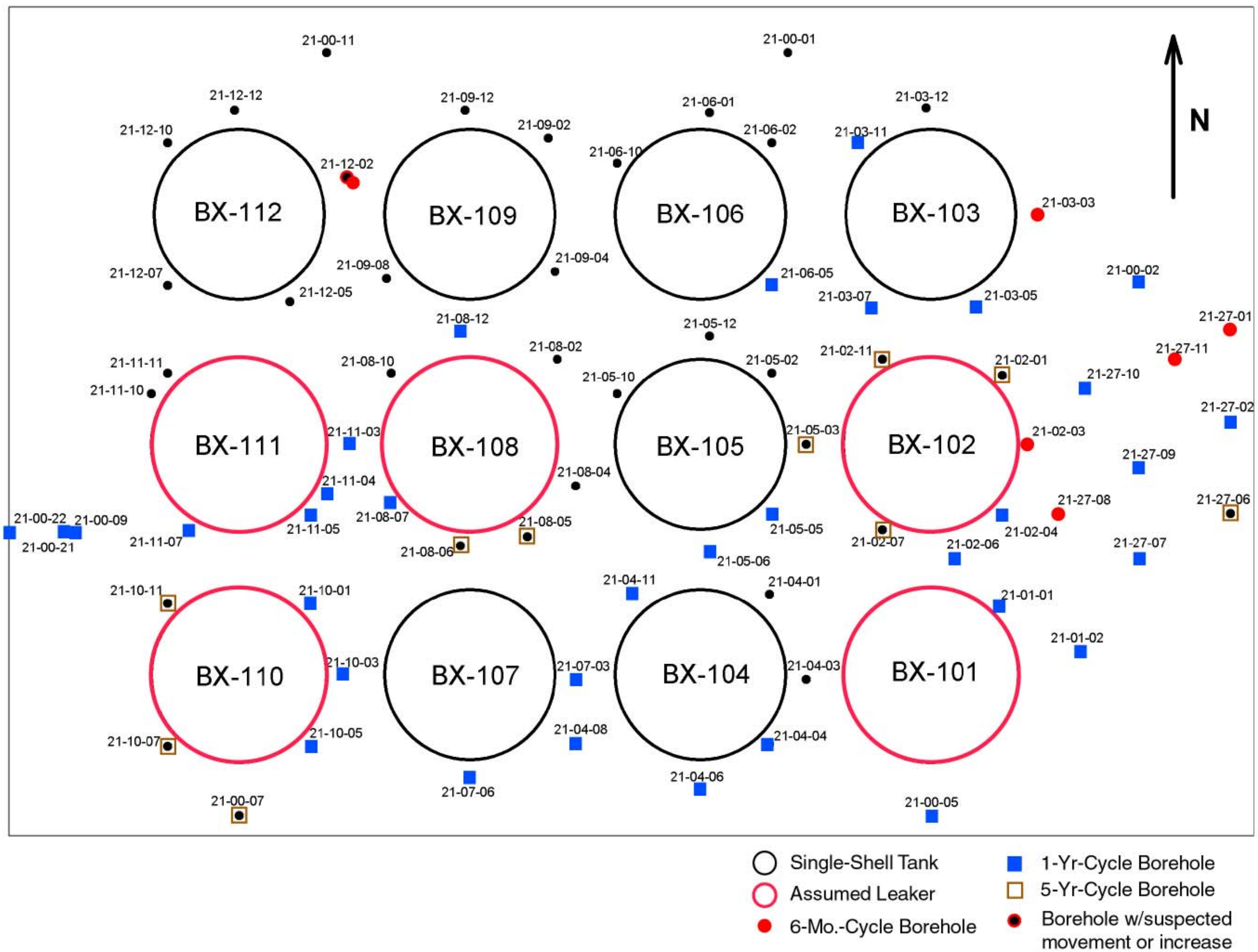


Hanford Plant West Coordinate
Hanford Plant North Coordinate
47900
47850
47800
47750
47700
47650
47600
47550
47500
41400
41350
41300
41250
41200
41150
A-104
A-105
A-106
A-101
A-102
A-103
N
10-00-01
10-00-02
10-04-12
10-04-01
10-05-12
10-05-10
10-05-02
10-06-12
10-06-10
10-06-02
10-04-10
10-05-09
10-06-09
10-06-04
10-04-08
10-04-04
10-04-05
10-05-08
10-05-07
10-05-05
10-06-07
10-06-05
10-04-07
10-01-11
10-01-01
10-02-11
10-03-11
10-03-01
10-02-01
10-03-02
10-01-10
10-02-10
10-03-10
10-01-03
10-01-09
10-00-08
10-02-03
10-01-28
10-01-39
10-02-08
10-01-04
10-01-08
10-03-04
10-01-16
10-01-05
10-02-05
10-03-07
10-00-04
10-01-06
10-02-06
10-03-05
10-00-07
10-00-06
Single-Shell Tank
Assumed Leaker
Caisson
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Leak Detection Lateral

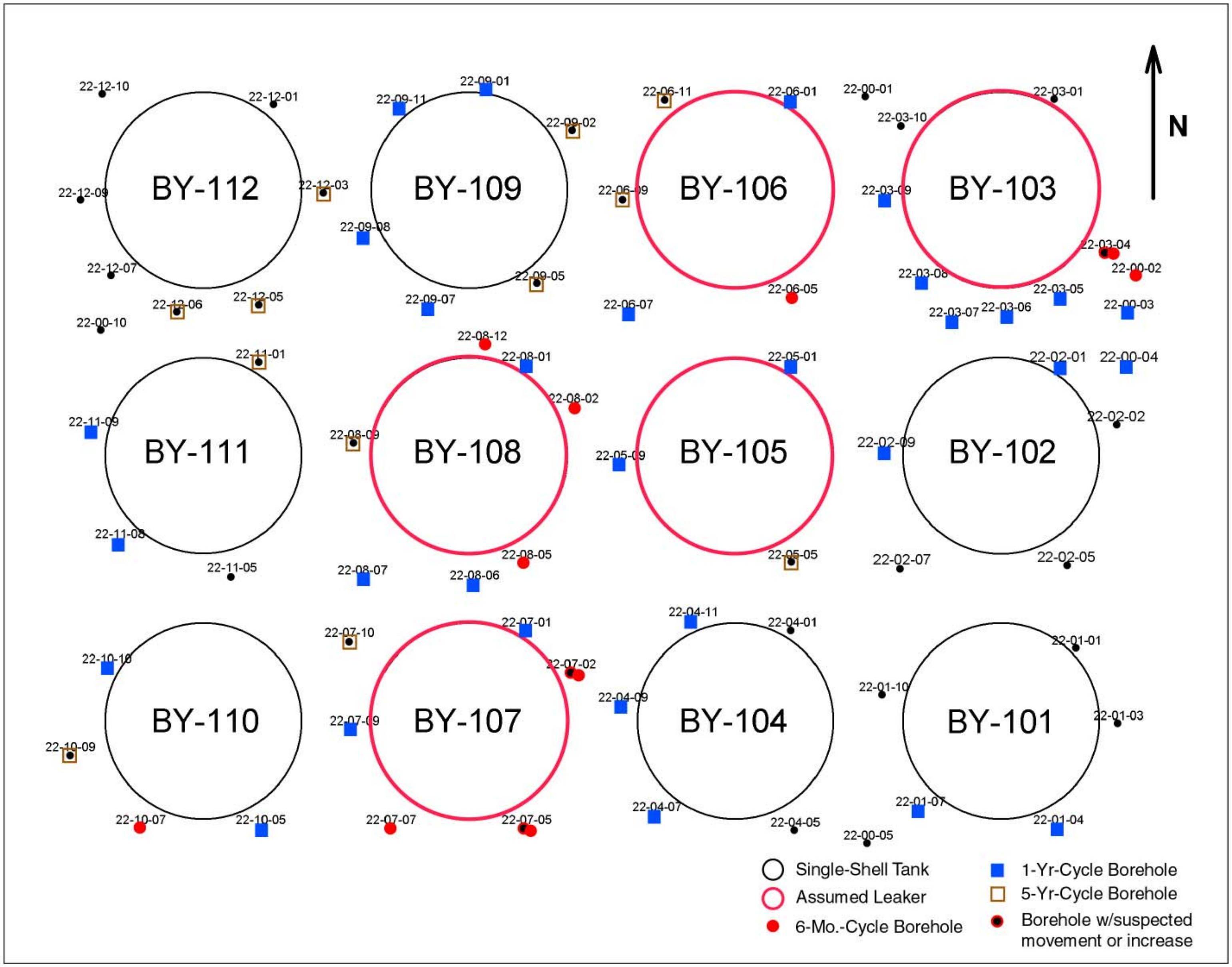


N
AX-103
AX-101
AX-104
AX-102
11-03-12
11-03-10
11-03-02
11-03-09
11-03-07
11-03-05
11-01-11
11-01-01
11-01-10
11-01-02
11-01-09
11-01-04
11-01-07
11-01-05
11-02-12
11-04-11
11-04-01
11-02-22
11-02-11
11-02-01
11-04-10
11-02-10
11-02-02
11-02-03
11-04-08
11-02-08
11-02-04
11-04-07
11-04-19
11-04-05
11-02-07
11-02-05
Single-Shell Tank
Assumed Leaker
Not Available for Monitoring
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Hanford Plant North Coordinate (feet)
Hanford Plant West Coordinate (feet)
41830
41780
41730
41680
41630
41580
41530
47650
47600
47550
47500
47450
47400
47350

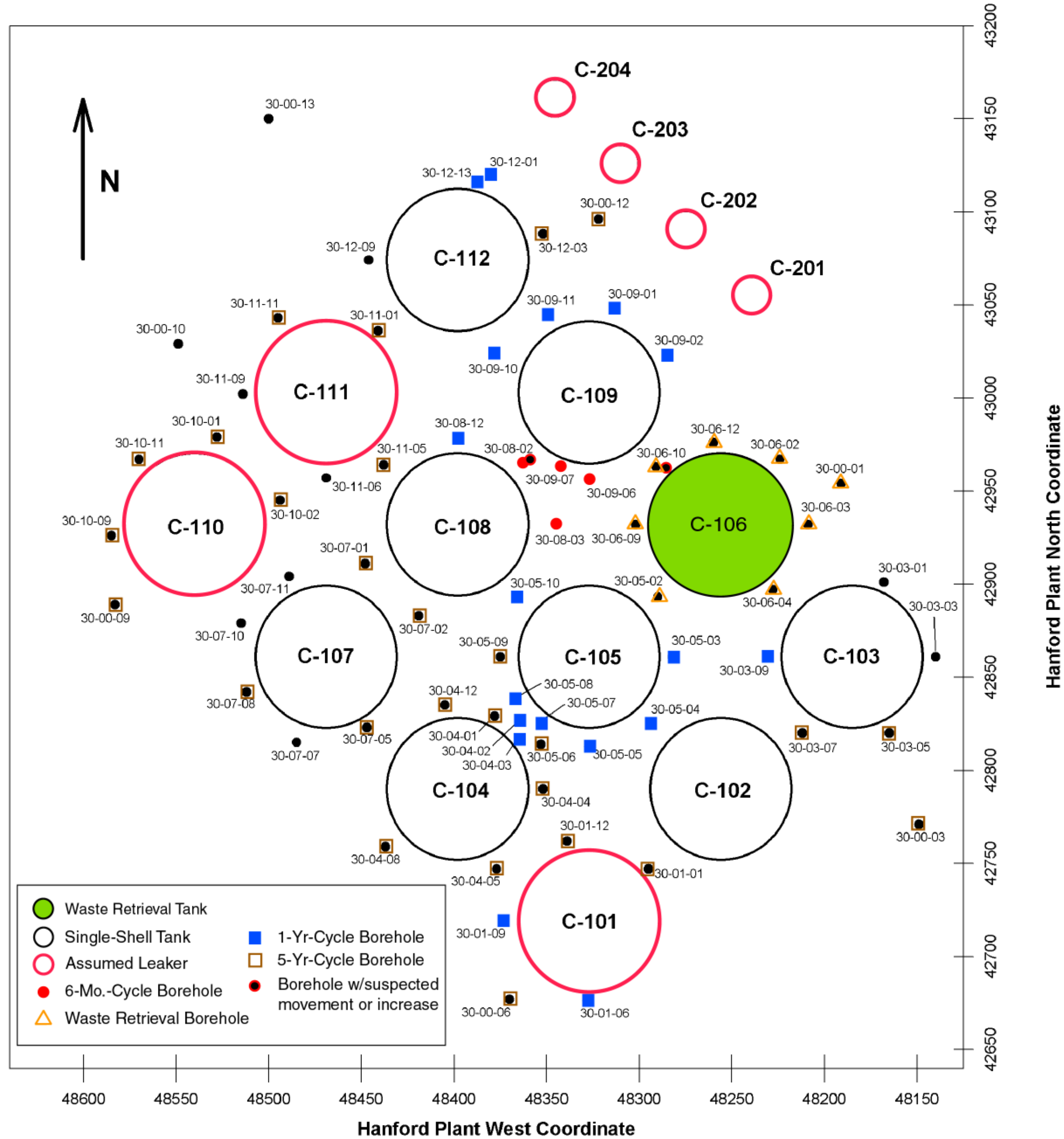

Hanford Plant West Coordinate
52900
52800
52700
52600
52500
Hanford Plant North Coordinate
45500
45400
45300
45200
N
B-204
B-203
B-202
B-201
B-112
B-109
B-106
B-103
B-111
B-108
B-105
B-102
B-110
B-107
B-104
B-101
20-00-23
20-00-11
20-00-01
20-12-11
20-12-02
20-09-11
20-09-02
20-06-11
20-06-02
20-03-11
20-03-02
20-12-03
20-06-03
20-03-03
20-03-09
20-12-07
20-12-06
20-09-06
20-06-06
20-03-06
20-08-02
20-02-11
20-00-02
20-11-09
20-08-09
20-08-03
20-02-09
20-02-03
20-08-07
20-08-05
20-00-09
20-02-07
20-02-05
20-10-12
20-07-11
20-05-06
20-01-11
20-01-01
20-10-02
20-07-02
20-04-03
20-01-03
20-10-09
20-07-08
20-10-07
20-07-05
20-04-06
20-01-07
20-01-06
20-01-05
20-00-07
20-00-05
Single-Shell Tank
Assumed Leaker
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole

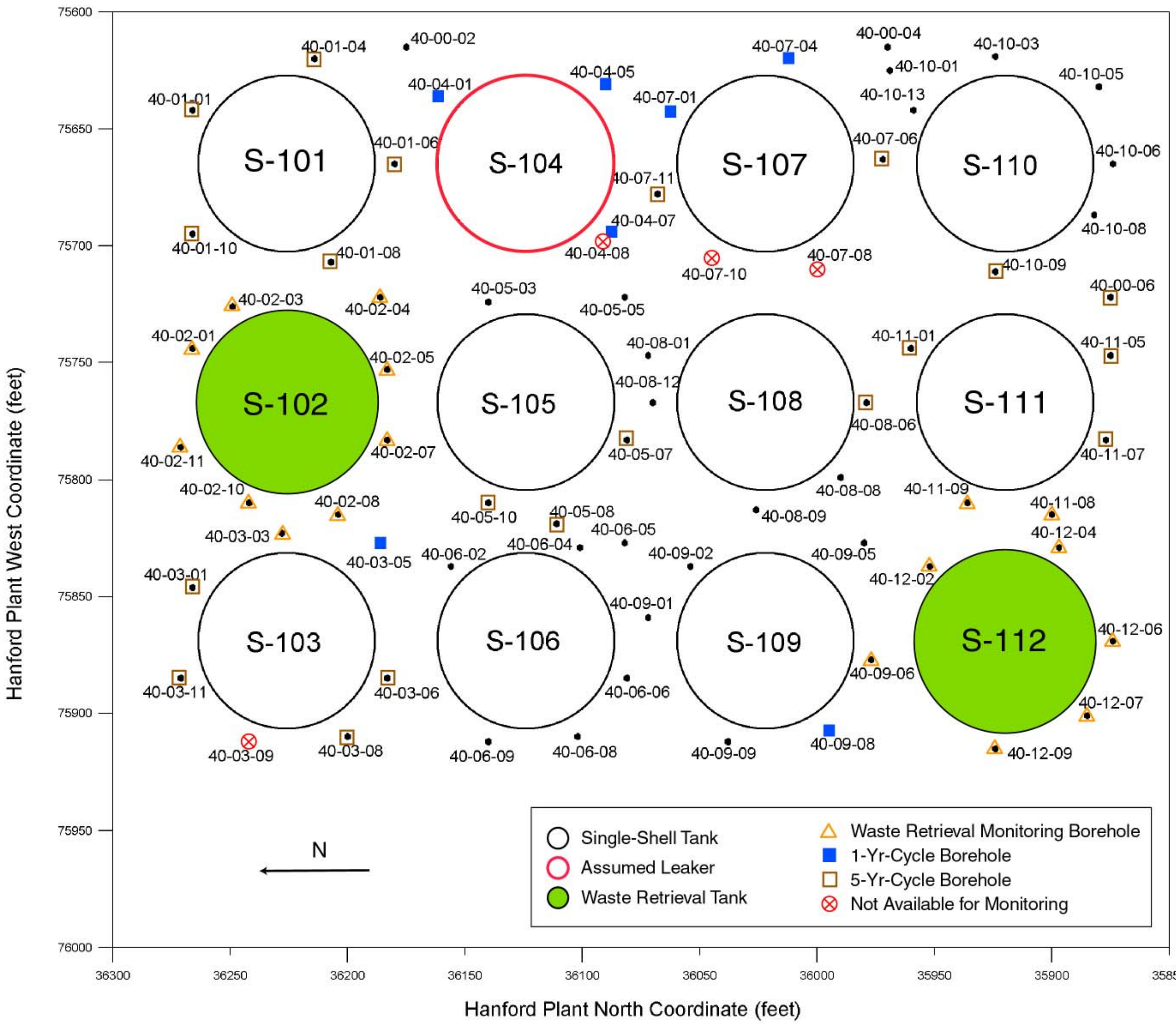


N
BX-112
BX-109
BX-106
BX-103
BX-111
BX-108
BX-105
BX-102
BX-110
BX-107
BX-104
BX-101
21-00-11
21-00-01
21-12-12
21-12-10
21-12-02
21-12-07
21-12-05
21-09-12
21-09-02
21-09-08
21-09-04
21-06-01
21-06-02
21-06-10
21-06-05
21-03-12
21-03-11
21-03-03
21-03-07
21-03-05
21-00-02
21-27-01
21-27-11
21-27-10
21-27-02
21-27-09
21-27-08
21-27-06
21-27-07
21-08-12
21-08-02
21-08-10
21-08-04
21-08-07
21-08-05
21-08-06
21-05-12
21-05-02
21-05-10
21-05-03
21-05-05
21-05-06
21-02-11
21-02-01
21-02-03
21-02-04
21-02-07
21-02-06
21-11-11
21-11-10
21-11-03
21-11-04
21-11-05
21-11-07
21-00-22
21-00-09
21-00-21
21-10-11
21-10-01
21-10-03
21-10-05
21-10-07
21-00-07
21-07-03
21-07-06
21-04-11
21-04-01
21-04-03
21-04-08
21-04-04
21-04-06
21-01-01
21-01-02
21-00-05
Single-Shell Tank
Assumed Leaker
6-Mo.-Cycle Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Borehole w/suspected movement or increase

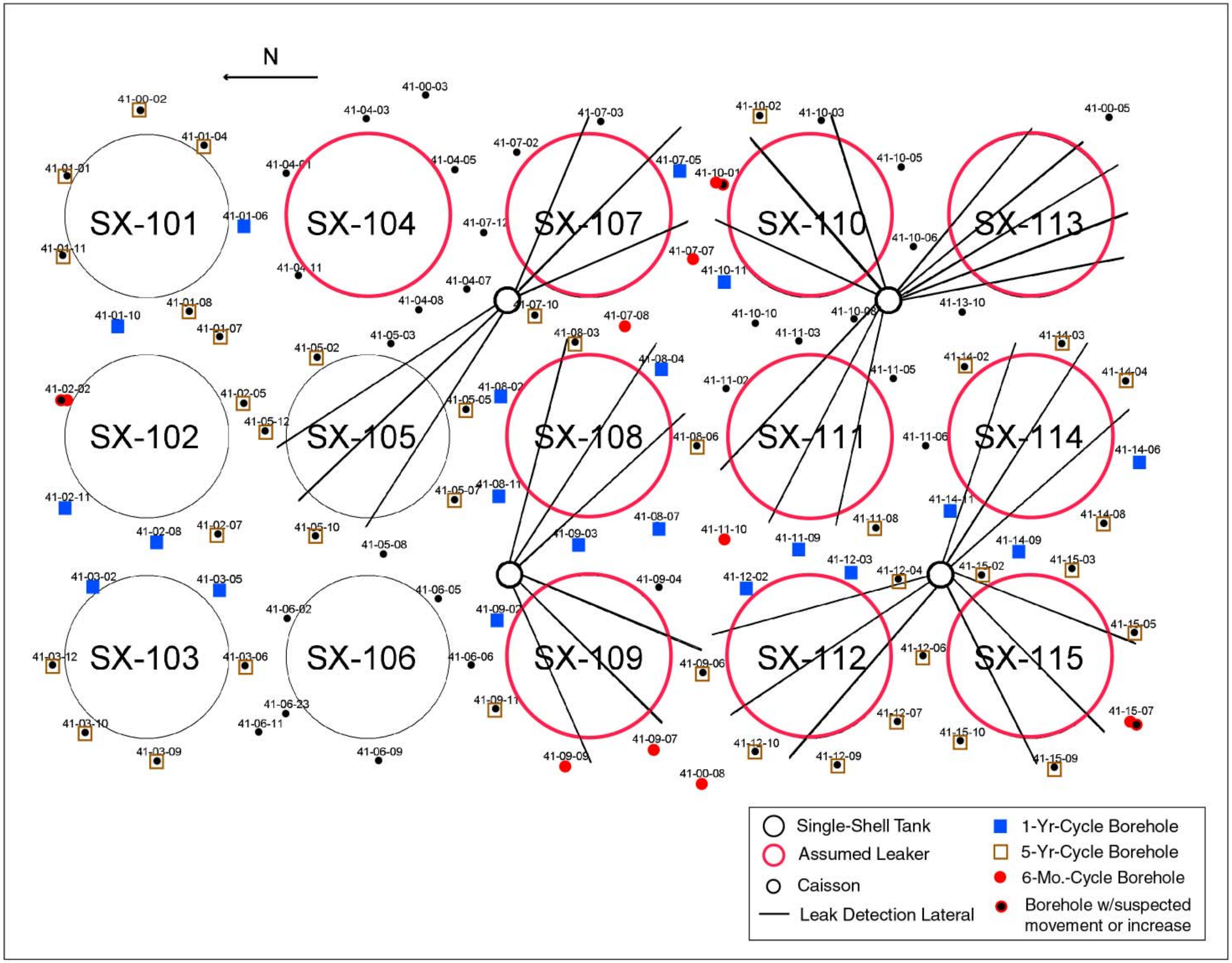


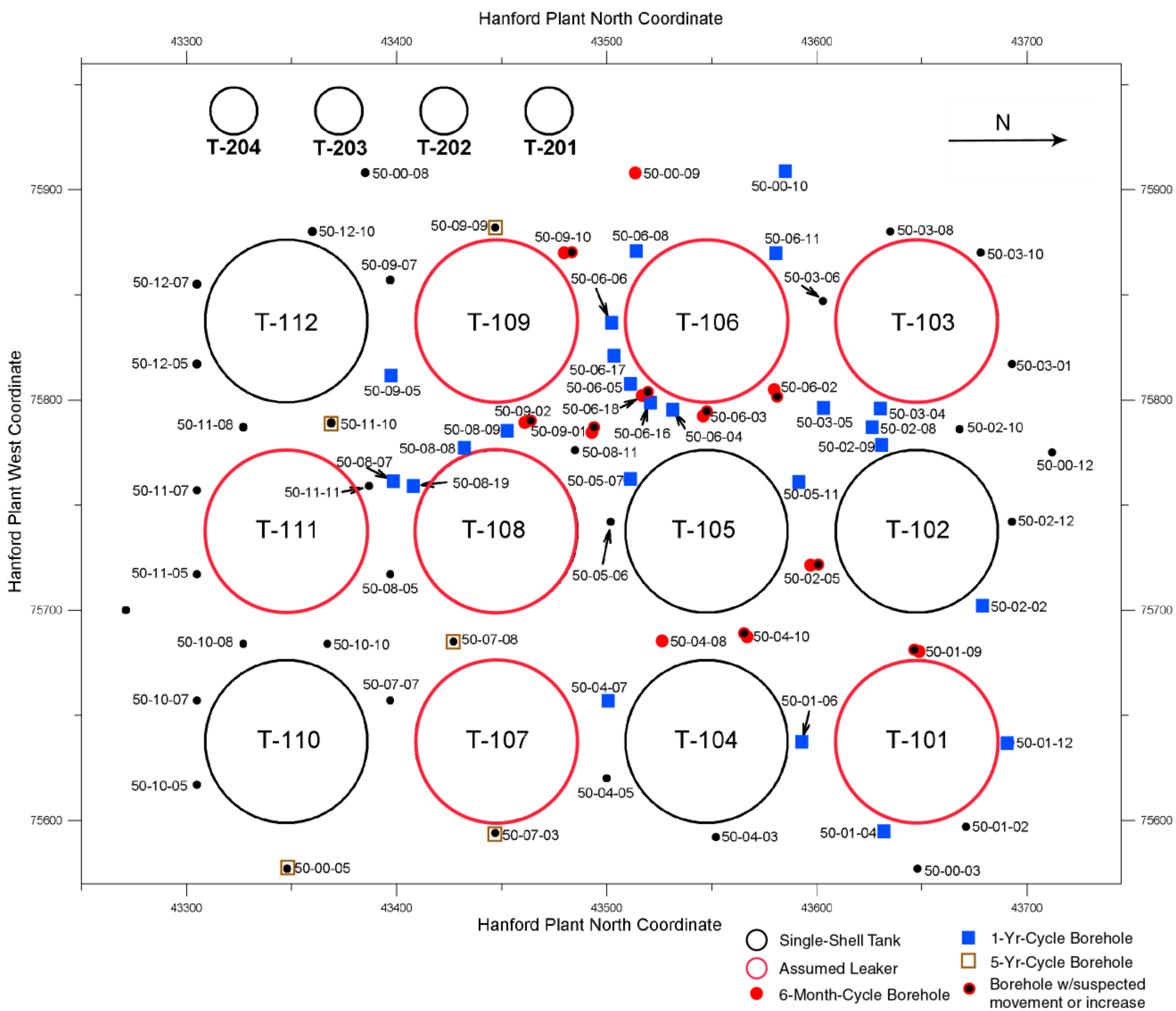
N
BY-112
BY-109
BY-106
BY-103
BY-111
BY-108
BY-105
BY-102
BY-110
BY-107
BY-104
BY-101
22-12-10
22-12-01
22-12-09
22-12-03
22-12-07
22-12-06
22-12-05
22-00-10
22-09-01
22-09-11
22-09-02
22-09-08
22-09-05
22-09-07
22-06-11
22-06-01
22-06-09
22-06-05
22-06-07
22-00-01
22-03-01
22-03-10
22-03-09
22-03-04
22-00-02
22-03-08
22-03-05
22-03-07
22-03-06
22-00-03
22-11-01
22-11-09
22-11-08
22-11-05
22-08-12
22-08-01
22-08-02
22-08-09
22-08-05
22-08-07
22-08-06
22-05-01
22-05-09
22-05-05
22-02-01
22-00-04
22-02-02
22-02-09
22-02-07
22-02-05
22-10-10
22-10-09
22-10-07
22-10-05
22-07-10
22-07-01
22-07-02
22-07-09
22-07-07
22-07-05
22-04-11
22-04-01
22-04-09
22-04-07
22-04-05
22-01-01
22-01-10
22-01-03
22-01-07
22-01-04
22-00-05
Single-Shell Tank
Assumed Leaker
6-Mo.-Cycle Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Borehole w/suspected movement or increase


N
C-204
C-203
C-202
C-201
C-112
C-111
C-109
C-110
C-108
C-106
C-107
C-105
C-103
C-104
C-102
C-101
30-00-13
30-12-13
30-12-01
30-00-12
30-12-03
30-12-09
30-09-11
30-09-01
30-11-11
30-11-01
30-00-10
30-09-10
30-09-02
30-11-09
30-10-01
30-08-12
30-06-12
30-06-02
30-10-11
30-11-05
30-08-02
30-06-10
30-00-01
30-11-06
30-09-07
30-09-06
30-10-02
30-06-03
30-10-09
30-08-03
30-06-09
30-07-01
30-05-10
30-05-02
30-03-01
30-07-11
30-06-04
30-00-09
30-03-03
30-07-10
30-07-02
30-05-09
30-05-03
30-03-09
30-05-08
30-04-12
30-05-07
30-07-08
30-05-04
30-04-01
30-04-02
30-04-03
30-07-05
30-07-07
30-05-06
30-05-05
30-03-07
30-03-05
30-04-04
30-01-12
30-00-03
30-04-08
30-04-05
30-01-01
30-01-09
30-00-06
30-01-06
Waste Retrieval Tank
Single-Shell Tank
Assumed Leaker
6-Mo.-Cycle Borehole
Waste Retrieval Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Borehole w/suspected movement or increase
48600
48550
48500
48450
48400
48350
48300
48250
48200
48150
Hanford Plant West Coordinate
43200
43150
43100
43050
43000
42950
42900
42850
42800
42750
42700
42650
Hanford Plant North Coordinate

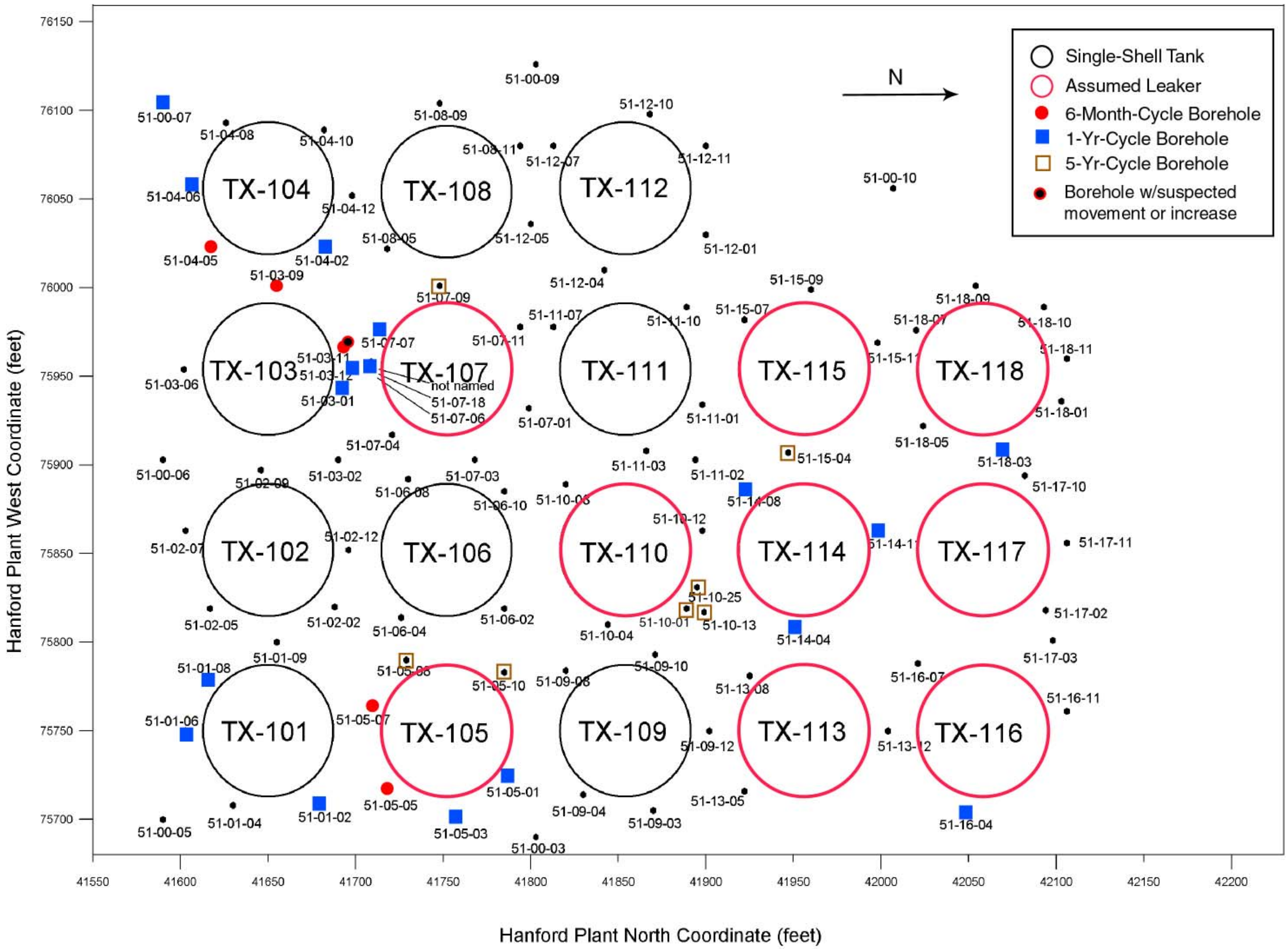


75600
75650
75700
75750
75800
75850
75900
75950
76000
Hanford Plant West Coordinate (feet)
36300
36250
36200
36150
36100
36050
36000
35950
35900
35850
Hanford Plant North Coordinate (feet)
S-101
S-104
S-107
S-110
S-102
S-105
S-108
S-111
S-103
S-106
S-109
S-112
40-00-02
40-00-04
40-00-06
40-01-01
40-01-04
40-01-06
40-01-08
40-01-10
40-02-01
40-02-03
40-02-04
40-02-05
40-02-07
40-02-08
40-02-10
40-02-11
40-03-01
40-03-03
40-03-05
40-03-06
40-03-08
40-03-09
40-03-11
40-04-01
40-04-05
40-04-07
40-04-08
40-05-03
40-05-05
40-05-07
40-05-08
40-05-10
40-06-02
40-06-04
40-06-05
40-06-06
40-06-08
40-06-09
40-07-01
40-07-04
40-07-06
40-07-08
40-07-10
40-07-11
40-08-01
40-08-06
40-08-08
40-08-09
40-08-12
40-09-01
40-09-02
40-09-05
40-09-06
40-09-08
40-09-09
40-10-01
40-10-03
40-10-05
40-10-06
40-10-08
40-10-09
40-10-13
40-11-01
40-11-05
40-11-07
40-11-08
40-11-09
40-12-02
40-12-04
40-12-06
40-12-07
40-12-09
N
Single-Shell Tank
Assumed Leaker
Waste Retrieval Tank
Waste Retrieval Monitoring Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Not Available for Monitoring

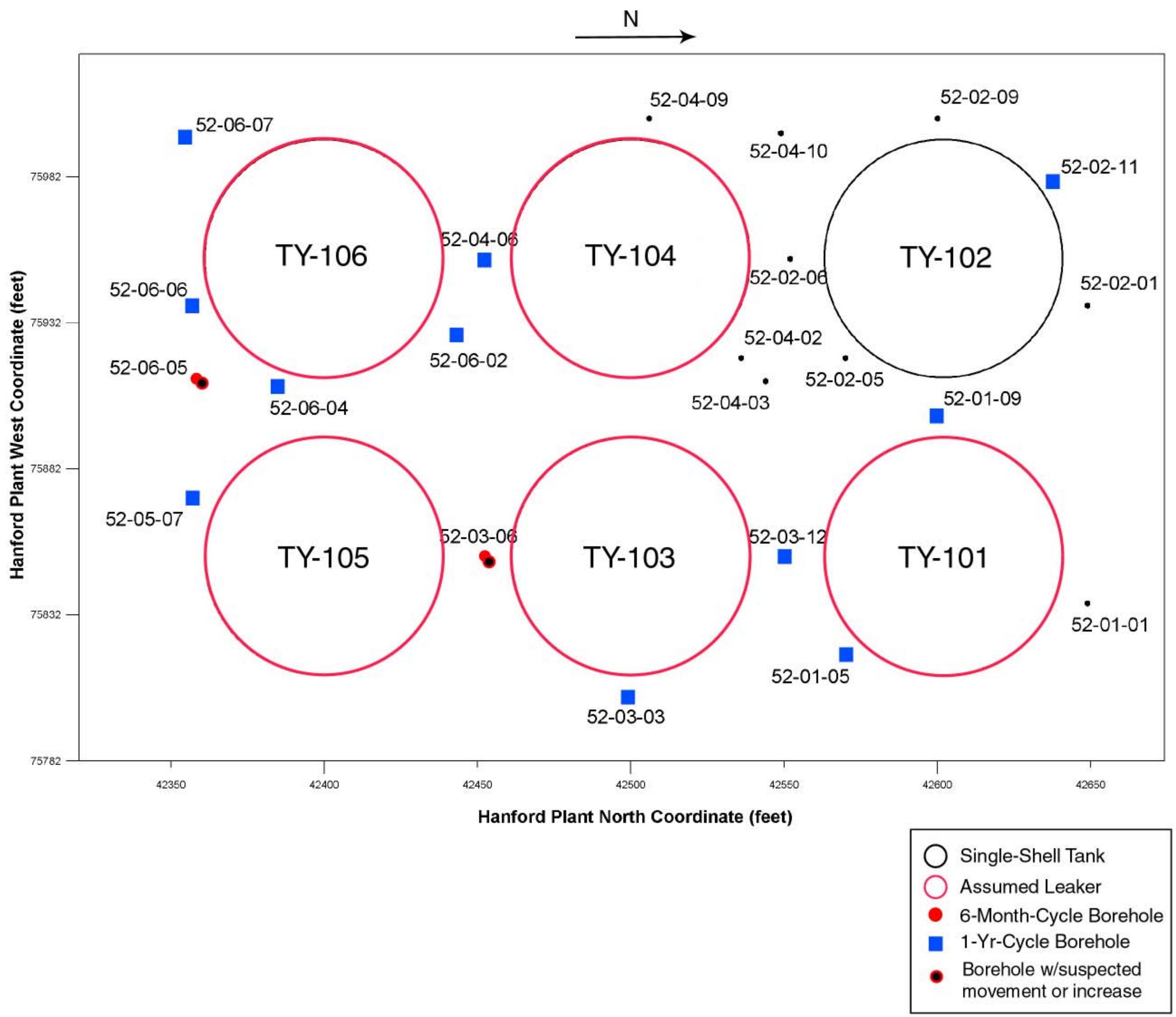

N
SX-101
SX-102
SX-103
SX-104
SX-105
SX-106
SX-107
SX-108
SX-109
SX-110
SX-111
SX-112
SX-113
SX-114
SX-115
41-00-02
41-00-03
41-00-05
41-00-08
41-01-04
41-01-06
41-01-08
41-01-10
41-02-05
41-02-08
41-02-07
41-03-02
41-03-05
41-03-06
41-03-09
41-04-03
41-04-05
41-04-07
41-04-08
41-05-02
41-05-03
41-05-05
41-05-07
41-05-10
41-05-08
41-06-05
41-06-06
41-06-23
41-06-11
41-06-09
41-07-03
41-07-02
41-07-05
41-07-07
41-07-10
41-07-08
41-08-03
41-08-04
41-08-06
41-08-07
41-09-03
41-09-04
41-09-06
41-09-07
41-10-02
41-10-03
41-10-05
41-10-06
41-10-11
41-10-10
41-11-03
41-11-05
41-11-08
41-11-09
41-11-10
41-12-02
41-12-03
41-12-04
41-12-07
41-12-09
41-13-10
41-14-03
41-14-04
41-14-06
41-14-08
41-14-09
41-15-03
41-15-05
41-15-07
41-15-10
Single-Shell Tank
Assumed Leaker
Caisson
Leak Detection Lateral
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
6-Mo.-Cycle Borehole
Borehole w/suspected movement or increase

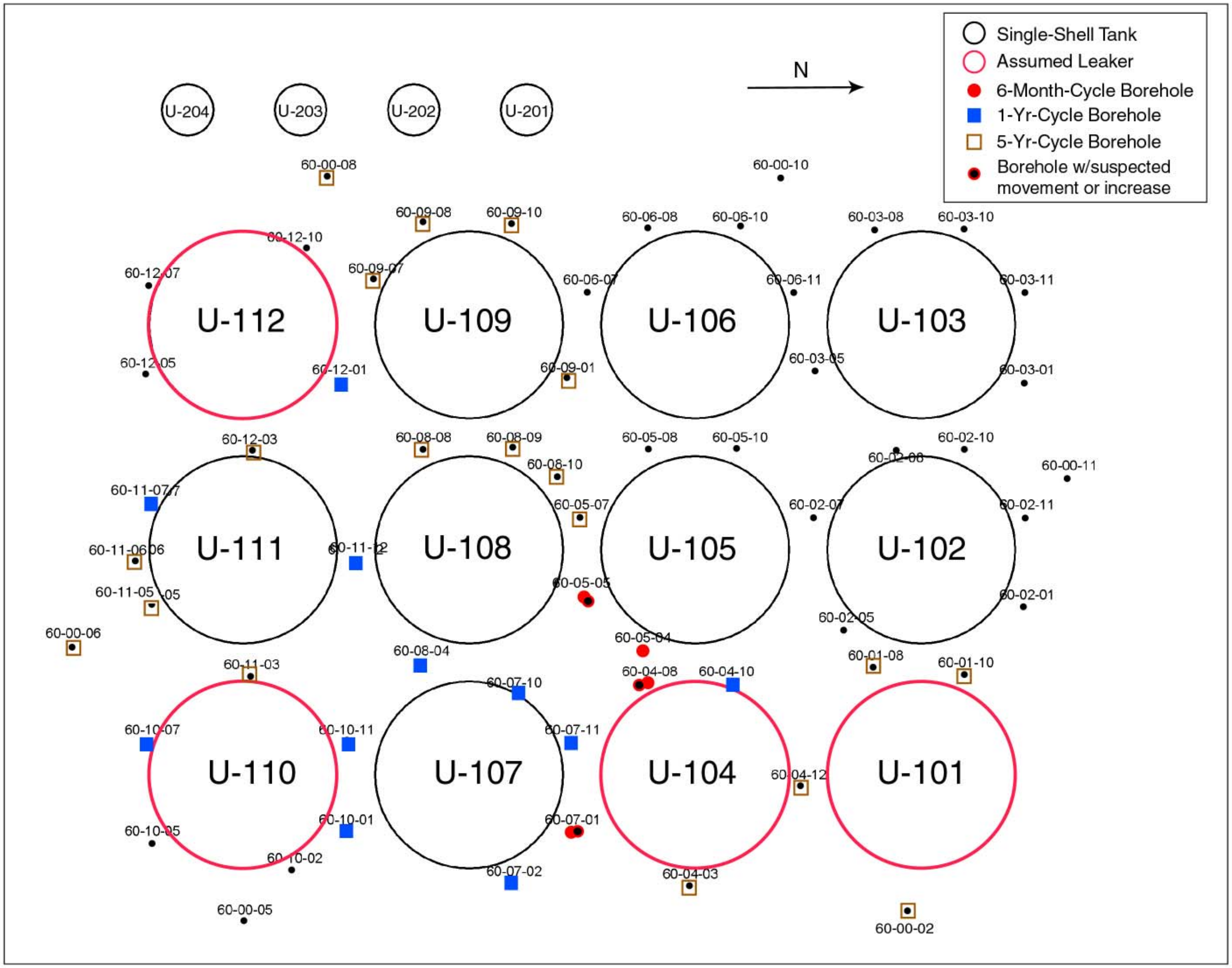


Hanford Plant North Coordinate
Hanford Plant West Coordinate
N
T-204
T-203
T-202
T-201
T-112
T-109
T-106
T-103
T-111
T-108
T-105
T-102
T-110
T-107
T-104
T-101
Single-Shell Tank
Assumed Leaker
6-Month-Cycle Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Borehole w/suspected movement or increase



Single-Shell Tank
Assumed Leaker
6-Month-Cycle Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Borehole w/suspected movement or increase
N
TX-101
TX-102
TX-103
TX-104
TX-105
TX-106
TX-107
TX-108
TX-109
TX-110
TX-111
TX-112
TX-113
TX-114
TX-115
TX-116
TX-117
TX-118
not named
Hanford Plant West Coordinate (feet)
Hanford Plant North Coordinate (feet)


N
TY-106
TY-104
TY-102
TY-105
TY-103
TY-101
52-06-07
52-04-09
52-02-09
52-04-10
52-02-11
52-04-06
52-02-06
52-02-01
52-06-06
52-06-02
52-04-02
52-06-05
52-02-05
52-06-04
52-04-03
52-01-09
52-05-07
52-03-06
52-03-12
52-01-01
52-01-05
52-03-03
75982
75932
75882
75832
75782
42350
42400
42450
42500
42550
42600
42650
Hanford Plant West Coordinate (feet)
Hanford Plant North Coordinate (feet)
Single-Shell Tank
Assumed Leaker
6-Month-Cycle Borehole
1-Yr-Cycle Borehole
Borehole w/suspected movement or increase


Single-Shell Tank
Assumed Leaker
6-Month-Cycle Borehole
1-Yr-Cycle Borehole
5-Yr-Cycle Borehole
Borehole w/suspected movement or increase
N
U-204
U-203
U-202
U-201
U-112
U-109
U-106
U-103
U-111
U-108
U-105
U-102
U-110
U-107
U-104
U-101
60-00-08
60-00-10
60-00-11
60-00-06
60-00-05
60-00-02
60-12-10
60-12-07
60-12-05
60-12-01
60-12-03
60-09-08
60-09-10
60-09-07
60-09-01
60-06-08
60-06-10
60-06-07
60-06-11
60-03-08
60-03-10
60-03-11
60-03-05
60-03-01
60-08-08
60-08-09
60-08-10
60-08-04
60-05-08
60-05-10
60-05-07
60-05-05
60-05-04
60-02-08
60-02-10
60-02-07
60-02-11
60-02-05
60-02-01
60-11-07
60-11-06
60-11-05
60-11-12
60-11-03
60-10-07
60-10-11
60-10-05
60-10-01
60-10-02
60-07-10
60-07-11
60-07-01
60-07-02
60-04-08
60-04-10
60-04-12
60-04-03
60-01-08
60-01-10

Appendix C
Comparison of RAS and SGLS Baseline Measurements of Boreholes Identified During FY 2004 that Suggest Contaminant Movement

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-02-03 (299-W23-188) (Unk)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36249**	**West: 75726**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: Unk**	**East: Unk**	**Elevation (m): Unk**
Drill Date: 2/27/1974	**Type: Cable Tool**	**Depth (ft): 98.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 6/18/03**	**D/W Reference: Stoller**	
Comments: None.			

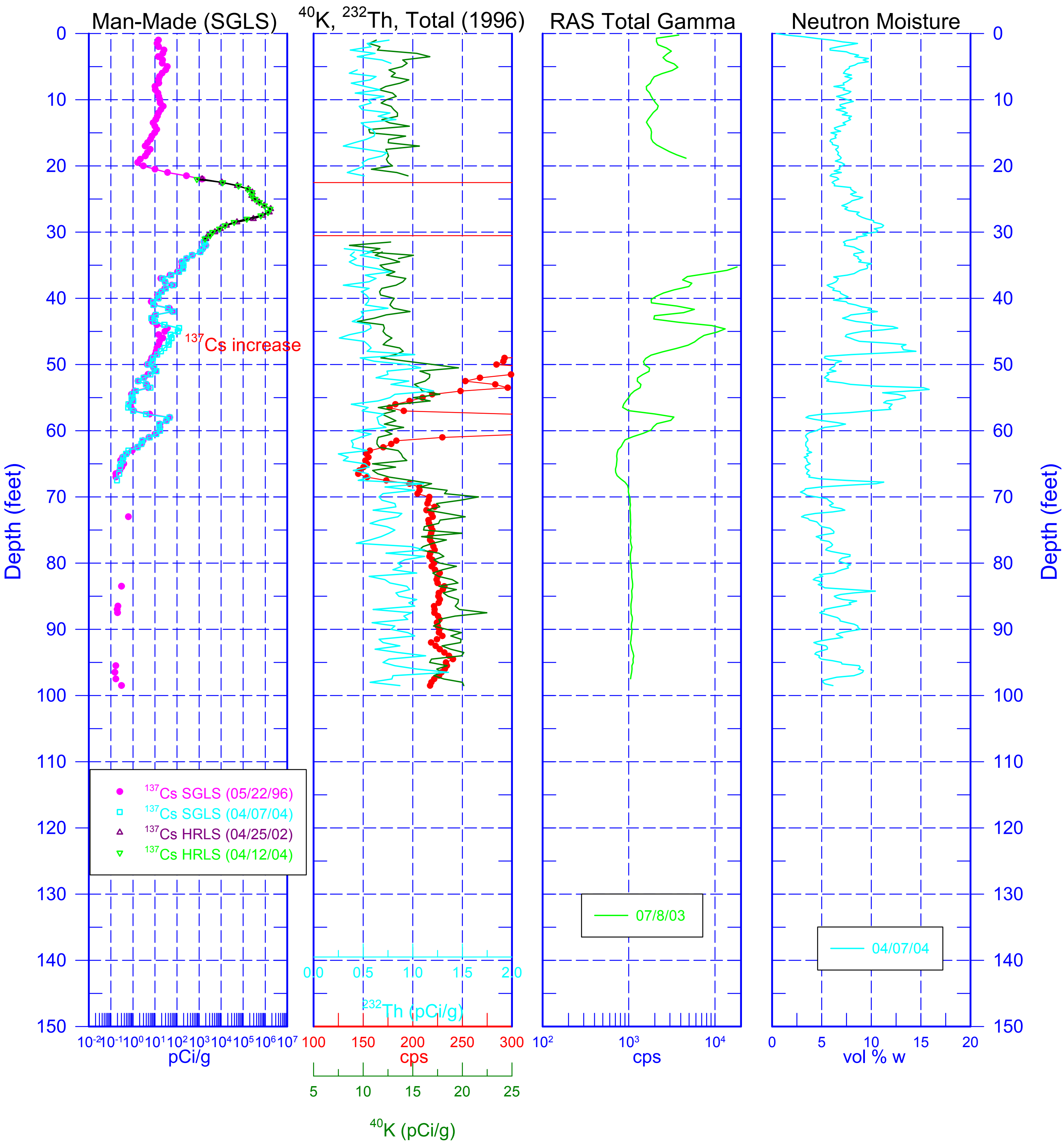
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/22/1996	SGLS	G1A	NA	1-98.5	MACTEC-ERS	Baseline
9/27/1999	HRLS	G1C	NA	20-35	MACTEC-ERS	Baseline-Highrate
4/25/2002	HRLS	G1C	NA	22-31	MACTEC-ERS	Highrate-Repeat
7/8/2003	RAS	Large-New	A	0-19&35-98	Stoller	Cs-137 inc. 44-47 ft.
7/8/2003	RAS	Small	A	15-23&29-40	Stoller	No Change
4/7/2004	SGLS	G2A	NA	31-70	Stoller	Cs inc. 44-47 ft. confirmed
4/7/2004	NMLS	NA	1	0-98.5	Stoller	Baseline
4/12/2004	HRLS	G1C	NA	22-31	Stoller	Tool efficiency change?

Tank S-102
40-02-03



Borehole Number (Alias): 30-06-10 (299-E27-71) (A6696)

Borehole Information

Site: C Farm, Tank C-106			
Coordinates (HAN Plant):	**North: 42963**	**West: 48291**	**Elevation (ft): 645.31**
Coordinates (WA Plane):	**North: 136578.287**	**East: 575172.083**	**Elevation (m): 197.808**
Drill Date: 11/30/1972	**Type: Cable Tool**	**Depth (ft): 129**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 2/17/04**	**D/W Reference: Stoller**	
Comments: None.			

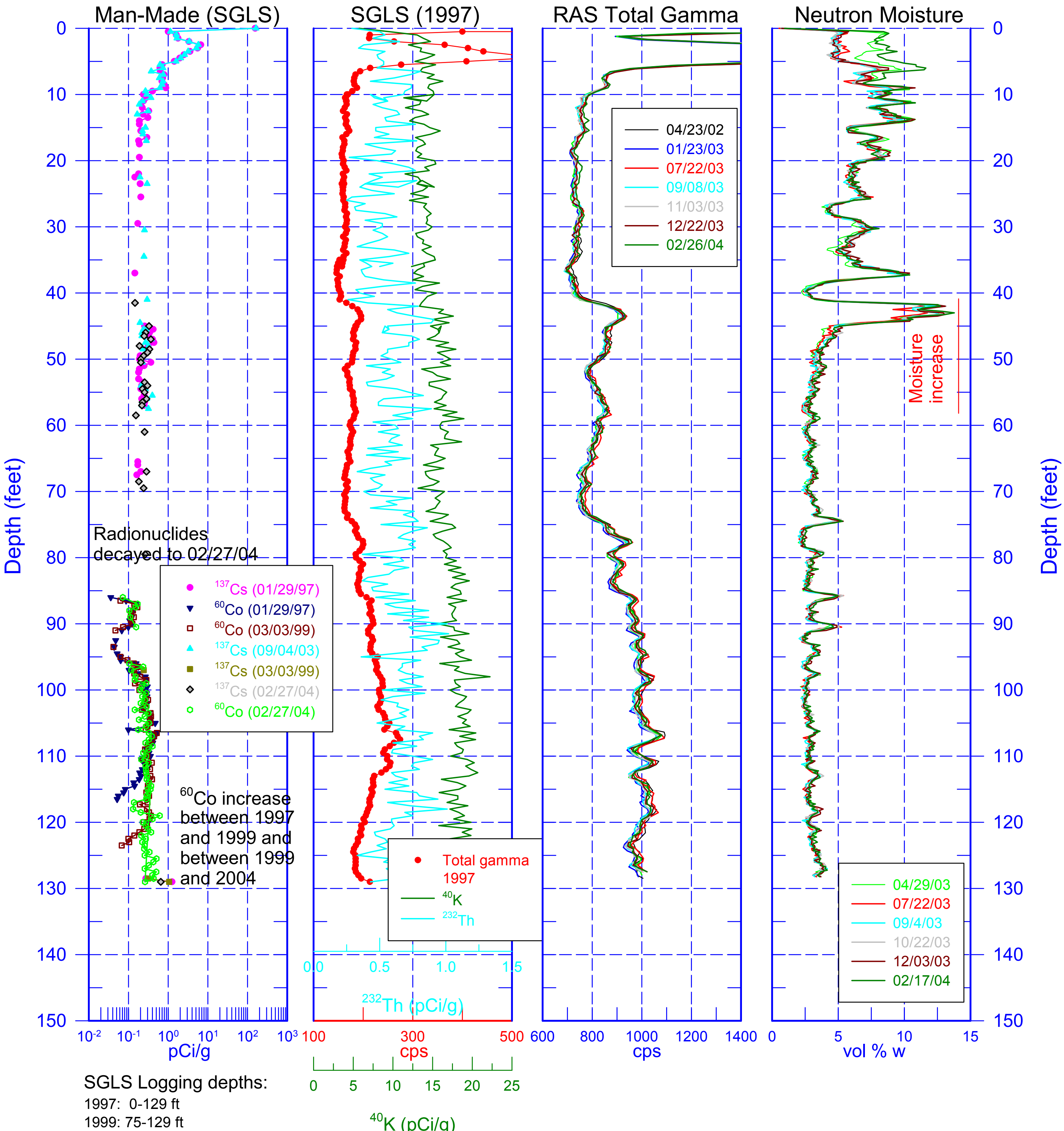
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	130	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
1993	RLS	Unk	NA	0-123	WHC	C-106 Investigation
01/29/97	SGLS	G1A	NA	0-129	MACTEC-ERS	Baseline
03/03/99	SGLS	G2B	NA	75-129	MACTEC-ERS	Continued Movement
04/23/02	RAS	Large	A	30-129	MACTEC-ERS	Poss. Increase 124-126
01/23/03	RAS	Large-New	B	0-129	Stoller	No change from above
04/22/03	RAS	Large-New	C	0-128	Stoller	Poss. Cs increase 4-5 ft
07/22/03	RAS	Large-New	D	0-128	Stoller	No change from above
04/29/03	NMLS	Moisture	1	0-128.25	Stoller	Moisture Baseline
07/22/03	NMLS	Moisture	2	0-128.25	Stoller	No Change
09/04/03	NMLS	Moisture	3	0-128.25	Stoller	No Change
09/04/03	SGLS	G2A	NA	0-60	Stoller	No Change
09/08/03	RAS	Large-New	E	0-128	Stoller	No Change
10/21/03	NMLS	Moisture	4	0-128.25	Stoller	No Change
11/03/03	RAS	Large-New	F	0-128	Stoller	No Change
12/03/03	NMLS	Moisture	5	0-128.25	Stoller	No Change
12/22/03	RAS	Large-New	G	0-128	Stoller	No Change
02/17/04	NMLS	Moisture	6	0-128.25	Stoller	No Change
02/26/04	RAS	Large-New	H	0-128	Stoller	No Change
02/27/04	SGLS	G2A	NA	40-129	Stoller	Cont. move. 124-129

Tank C-106
30-06-10



SGLS Logging depths:
1997: 0-129 ft
1999: 75-129 ft
2003: 0-60 ft
2004: 0-129 ft

Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 30-08-02 (299-E27-94) (A6719)

Borehole Information

Site: C Farm, Tank C-108			
Coordinates (HAN Plant):	**North: 42965**	**West: 48363**	**Elevation (ft): 647.00**
Coordinates (WA Plane):	**North: 136578.828**	**East: 575150.01**	**Elevation (m): 197.951**
Drill Date: 9/30/1974	**Type: Cable Tool**	**Depth (ft): 99**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 12/9/03**	**D/W Reference: Stoller**	
Comments: None.			

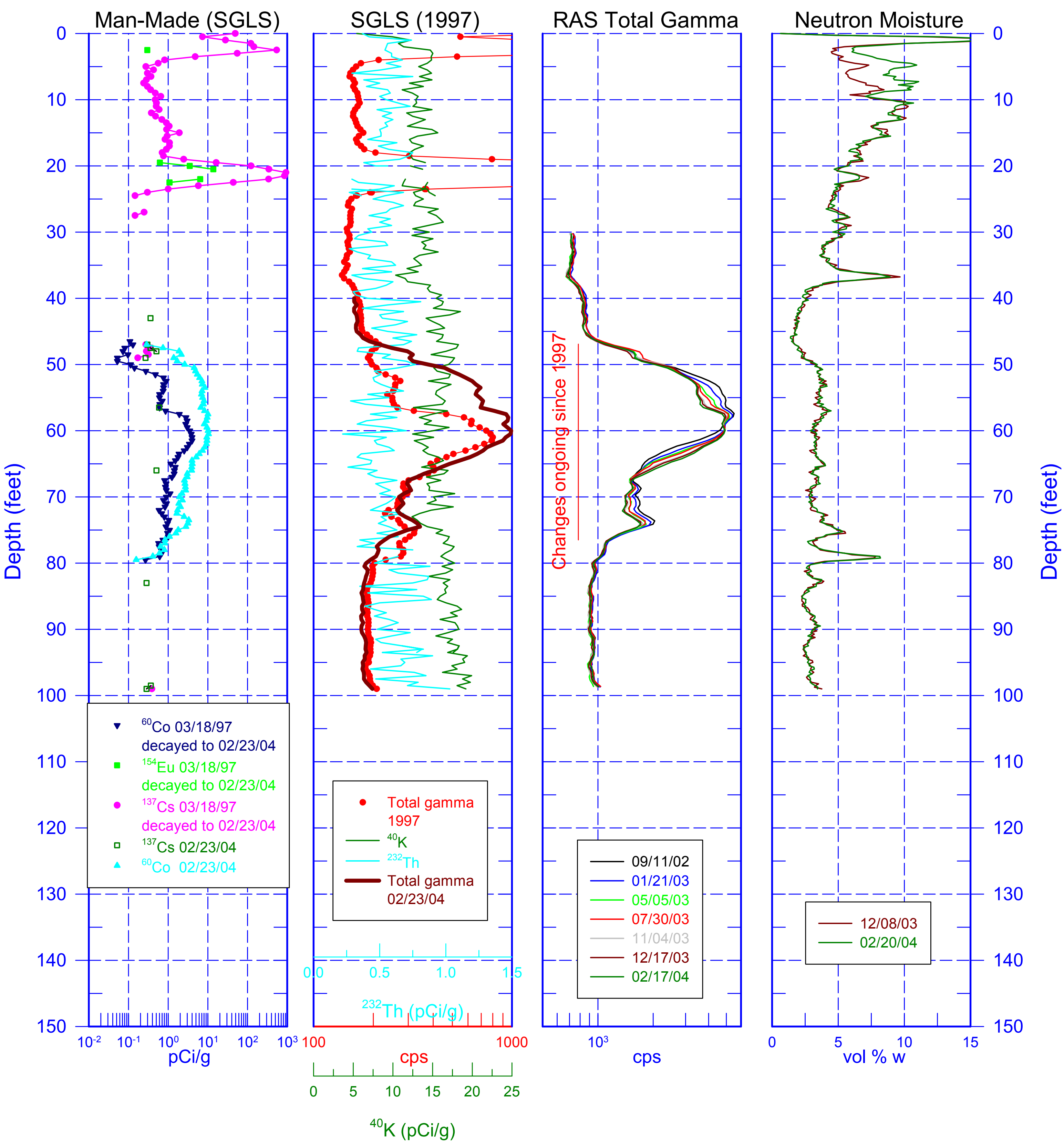
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
03/18/97	SGLS	G1B	NA	0-99	MACTEC-ERS	Baseline
09/11/02	RAS	Large	A	30-99	Stoller	Co-60 increase 49-75 ft
09/12/02	RAS	Large	B	30-99	Stoller	No change from above.
01/21/03	RAS	Large-New	C	30-99	Stoller	Downward Movement
05/05/03	RAS	Large-New	D	30-99	Stoller	Downward Movement
07/30/03	RAS	Large-New	E	30-98	Stoller	Downward Movement
11/04/03	RAS	Large-New	F	30-98	Stoller	Downward Movement
12/08/03	NMLS	Moisture	1	0-99	Stoller	Moisture baseline
12/17/03	RAS	Large-New	G	30-99	Stoller	No change from above.
02/17/04	RAS	Large-New	H	30-99	Stoller	Downward Movement
02/20/04	NMLS	Moisture	2	0-99	Stoller	No change
2/23/2004	SGLS	G2A	NA	40-99	Stoller	Confirm Co-60 incr. above

Tank C-108
30-08-02



Appendix D
241-C-106 Tank Waste Retrieval Project
Interim Report of Drywell Monitoring Data

Stoller
Hanford Office

March 22, 2004

241-C-106 Tank Waste Retrieval Project
Interim Report of Drywell Monitoring Data

Introduction

241-C-106 is an underground radioactive waste storage tank located in the 241-C Tank Farm in the 200 East Area of the Hanford Site. This tank is a 75-foot (ft)-diameter underground domed concrete structure, with a carbon steel liner on the sides and bottom. The base of the tank is approximately 38 ft below ground surface, and approximately 9 ft of backfill covers the dome. Nominal capacity of the tank is 533,000 gallons. Waste retrieval operations for this tank were successfully concluded in December 2003 with the removal of all but a nominal amount of tank waste.

Waste retrieval operations required limited additions of water and oxalic acid to mobilize the waste for removal. In the Process Control Plan (May and Reynolds 2003), the baseline leak-detection method is gamma and neutron moisture logging in drywells surrounding C-106 on a six-week schedule supplemented by moisture monitoring with hand-held instruments twice per week. Routine gamma monitoring in drywells with the radionuclide assessment system (RAS) is performed by CH2M HILL Group, Inc., (CH2M HILL) personnel with technical oversight by the S.M. Stoller Corporation (Stoller). Logging with the neutron moisture logging system (NMLS) and high-resolution spectral gamma logging system (SGLS) is performed by Stoller personnel. The hand-held moisture measurements are under the purview of CH2M HILL and will only be discussed here in the context of the log data.

Observations of increasing moisture content in the vicinity of C-106 resulted in the initiation of a "Problem Evaluation Request" (PER) on December 3, 2003. The PER specifically stated *"Increased moisture content (~1%) in the vadose zone beneath Tank 241-C-106 may be indicative of a loss of tank integrity. Moisture monitoring is done because, few if any mobile gamma emitting radionuclides remain in the tank.*"

The purpose of this letter report is to summarize available drywell data collected to date and address the concerns raised in the PER.

Available Geophysical Log Data

Gross gamma logs were routinely collected in C Farm drywells until 1994. These data are available in electronic format from 1975 to 1994 and have been evaluated by Randall and Price (2001).

Other studies conducted on tank C-106 in the past include discussion of subsurface conditions and geophysical log data. These studies include Washington State Department of Ecology (1992), Brodeur (1993), and Barnes (2000). These reports pre-date the current retrieval effort and are not discussed further in this report because they provide no information regarding the impact of recent retrieval operations.

A baseline of subsurface contamination conditions in the vicinity of tank C-106 was established in 1997 and reported in the *Tank Summary Data Report for C-106* (DOE 1997). A discussion of subsurface contamination conditions and visualization of subsurface contaminant plumes was published in the *C Tank Farm Report* (DOE 1998) and updated in 2000 (DOE 2000).

In response to the PER, moisture data were acquired in borehole 30-05-02 on December 8, 2003, five days after the PER was issued and six days after the previous moisture measurement. Additional boreholes (30-08-02, 30-09-07, and 30-09-06) were selected for moisture measurements to help assess changes in subsurface moisture away from the tank.

SGLS data were not acquired until February 2004 due to inclement weather and system availability. RAS measurements were acquired during December 2003. No apparent increases in gamma activity were observed. SGLS measurements were collected in late February and early March in boreholes 30-06-02, -04, -09, -10, 30-05-02, and 30-08-02.

Table 1 below summarizes the number of logging events with each logging system for each borehole that can provide relevant information to the tank C-106 retrieval operations. Figure 1 shows the locations of these boreholes relative to tank C-106. Logging depth intervals where apparent changes in gamma activity and/or moisture have been observed are indicated.

Table 1. Summary of Logging Measurements Acquired for Evaluation of the C-106 Retrieval Operations

Borehole	**SGLS**	**RAS**	**NMLS**	**Gamma Change**	**Moisture Change**
30-06-02	2	7	6	None	56-72 ft
30-06-03	1	7	6	None	55-67 ft
30-06-04	2	8	6	85-91 ft	46-55 ft
30-05-02	2	8	7	None	41-62 ft
30-06-09	2	8	6	None	50-72 ft
30-06-10	3	7	6	116-130 ft	42-54 ft
30-06-12	1	7	6	None	50-60 ft
30-08-02	2	7	2	47-80 ft	None
30-09-07	1	7	2	None	None
30-09-06	1	7	2	78-87 ft	None

Figures 2a through 11a present a graphical summary of these data collected in support of the C-106 retrieval to March 2004; retrieval operations ceased December 31 (Hanlon 2003). These data include the man-made radionuclides (^{137}Cs and ^{60}Co), ^{40}K, ^{232}Th concentrations, and total gamma collected with the SGLS and RAS, and NMLS measurements.

Figures 2b through 11b show the NMLS data with depth intervals expanded so that subtle changes in moisture can be viewed. A limited number of handheld moisture measurements are also included that span the time period from July to October 2003.

Figure 12 shows a cross section (A-A') from borehole 30-08-02 west of tank C-106 to borehole 30-00-01 east of the tank. The cross section indicates a slight east-northeast stratigraphic dip in the vicinity of tank C-106.

Preliminary Observations and Findings

When all available data are compiled, pre-retrieval vadose zone conditions in the immediate vicinity of tank C-106 appear to not have significantly changed for either moisture or gamma activity up to March 2004, except for borehole 30-06-10, where gamma activity shows downward and lateral movement below 86-ft depth. This contaminant movement was recognized in the tank summary data report (DOE 1997). It was confirmed by SGLS logging and reported to DOE in March 1999 (Bertsch 1999).

Slight moisture increases are shown in all boreholes, with the largest increases (approximately 1 percent) indicated in boreholes 30-05-02 and 30-06-09 located southwest of tank C-106. These moisture increases appear to have occurred between July and September 2003, although this is not conclusive. The changes appear to have stabilized since December 2003, although additional measurements should be acquired to confirm this observation.

Generally, the top 10 ft of the boreholes show decreasing moisture content in the sediments between April and December 2003 with increases between December 2003 and March 2004. The decrease is likely due to evapotranspiration during the warmer months, and the increase is likely the result of infiltration from rain and snowmelt. No changes are apparent between the upper 10.0 ft and the depths below the tanks where moisture changes have been observed. Figure 4c compares the current moisture profile to moisture measurements acquired in 1976 in borehole 30-06-04. The moisture profiles are very similar, suggesting relatively static conditions in the vadose zone over almost 30 years.

The seven or eight RAS measurements collected in boreholes around tank C-106 do not indicate any increase in gamma activity within the intervals of moisture increases or high moisture zones in the vicinity of tank C-106. The numerous thin zones of relatively high moisture appear to be "perched" above fine-grained sediment layers, some of which can be correlated across the area of the cross section. For example, the excavation surface at an elevation of approximately 612 ft (log depth 38 ft) appears to be associated with relatively thin intervals of higher moisture content (Figure 12). Another significant layer is observed at an elevation of 570 ft (log depth 80 ft). This layer appears to influence lateral movement of contamination, but it may not be continuous across the tank farm.

SGLS measurements were collected in boreholes 30-06-02, -04, -09, -10, 30-05-02, and 30-08-02. These data were compared to SGLS data collected in 1997. As with the RAS measurements, no significant changes are observed in depth intervals where slightly elevated moisture was detected. Changes were observed in boreholes 30-08-02 and 30-06-10. In borehole 30-08-02 (Figures 9 and 12), ^{60}Co contamination continued to increase between elevations of 602 and 576 ft (log depths 47 to 73 ft). In borehole 30-06-10, ^{60}Co contamination is encountered at elevation 564 (86-ft log depth). After accounting for decay, ^{60}Co concentrations appear to be relatively stable between 86-ft and 112-ft depth, but the lower extent of the ^{60}Co plume has moved downward from 116-ft depth in 1997 to the bottom of the borehole at 129 ft by 2004. Figure 12 shows the relationships between the boreholes. The ^{60}Co contamination appears to originate from the vicinity of tank C-108 and follows stratigraphic dip to the east-northeast, and probably extends past borehole 30-06-12 at depths greater than 130 ft. This contamination was recognized well before retrieval operations began, and does not appear to have been impacted by retrieval activities in tank C-106. However, the existence of this plume and its continued movement downward and to the east do call into question the integrity of tank C-108.

Conclusions

The premise stated in the PER for moisture logging in support of the tank C-106 retrieval is that "few if any mobile gamma emitting radionuclides remain in the tank." However, when moisture increases were observed, requests for gamma logging were made to confirm or deny the existence of a tank leak. If the assumption is made that there are in fact no mobile gamma-emitting radionuclides present in the waste material, then the observed zones of moisture increase could be an indication of a tank leak associated with retrieval operations. However, Stoller's experience with tank farm logging suggests that even though radionuclides such as ^{137}Cs and ^{60}Co are not considered highly mobile, detectable gamma activity would be associated with any tank waste in the vadose zone. No long-term baseline has been established for neutron moisture data, and the observed increases in moisture content may simply be related to seasonal fluctuations. In Stoller's opinion, the lack of observable increases in gamma activity associated with the moisture increases strongly suggests that the moisture increases are related to seasonal fluctuations, but available data are not sufficient to conclusively prove that no tank leak occurred.

Subsurface contamination may not necessarily be associated with high moisture content. For example, the ^{60}Co contamination movement in boreholes 30-08-02 and 30-06-10 (Figure 12) does not appear to be associated with moisture anomalies. It appears that if moisture is driving contaminant movement, the magnitude of the changes may be very small (e.g., approximately 1% volumetric fraction) such as observed around tank C-106. The ^{60}Co contamination in borehole 30-08-02 occurs in the same general depth range as moisture increases around tank C-106. Therefore, perhaps slight moisture increases resulting from natural seasonal fluctuations are sufficient to provide a mechanism to drive contamination through the vadose zone.

Experience with leak-detection monitoring around tank C-106 strongly suggests that moisture measurements alone are not sufficient. Gamma activity measurements in the existing boreholes remain an important component of leak-detection monitoring, because a significant increase in gamma activity provides unequivocal evidence of a leak.

Currently, gamma measurements with the RAS that can be compared with the SGLS baseline have been acquired in all but a few boreholes in C Farm. Results of these measurements indicate that only three boreholes (30-08-02, -03, and 30-06-10) have shown contaminant movement since 1997. These boreholes are all in the same general vicinity.

Recommendations

Continued reliance on neutron moisture measurements as the primary means of leak detection is not recommended; no long-term baseline of neutron moisture measurements has been established, and it is impossible to determine if small increases are related to waste retrieval operations or simply to normal seasonal fluctuations. Logging systems capable of concurrent measurement of both gamma activity and moisture content are available and should be incorporated into leak detection, monitoring, and mitigation (LDMM) requirements for tank retrieval operations as soon as possible. Other geophysical methods, such as high-resolution resistivity (HRR) also may play an important role in leak detection. However, methods such as HRR also respond primarily to changes in moisture content, which are not necessarily related to tank leaks. Therefore, it is likely that any anomalies detected by HRR will require investigation by gamma logging.

The elevated moisture measured around tank C-106 should be investigated further. If the premise that the tank contains no mobile gamma-emitting radionuclides is accurate, the SGLS and RAS measurements do not conclusively rule out a potential tank leak during retrieval operations. ^{99}Tc or other mobile radionuclides not detectable by gamma logging could be associated with the moisture increases.

Tank C-108 should be investigated for possible leakage as the source of the plume observed in borehole 30-08-02 and 30-06-10. This ^{60}Co plume should be investigated for co-contaminants such as ^{99}Tc, as well as, to determine contaminant transport characteristics that result in this dynamic situation.

References

Barnes, D.A., 2000. *Spectral Drywell Scans Around C-106 During Retrieval Operations*, RPP-7305, CH2M Hill Hanford Group, Inc., Richland, Washington.

Berstch, J.F, 1999. Letter to DOE-RL Project Manager John Silko, Subject: "Contaminant Movement in C Tank Farm," MACTEC-ERS, Richland, Washington, March 10, 1999.

Brodeur, J.R., 1993. *Assessment of Unsaturated Zone Radionuclide Contamination Around Single-Shell Tanks 241-C-105 and 241-C-106*, WHC-SD-EN-TI-185, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B.M, 2003. *Waste Tank Summary Report for Month Ending December 31, 2003*, HNF-EP-0182, Rev. 189, CH2MHILL Hanford Group, Inc., Richland, Washington.

May, T.H., and D.A. Reynolds, 2003. *Process Control Plan for Tank 241-C-106 Acid Dissolution,* RPP-16462, Rev. 2, CH2M Hill Hanford Group, Inc., Richland, Washington.

Myers, D.A., 2003. Problem Evaluation Request, PER-2003-4818, CH2M Hill Hanford Group, Inc., Richland, Washington, December 3, 2003.

Randall, R., and R. Price, 2001. *Analysis and Summary Report of Historical Dry Well Gamma Logs for 241-C Tank Farm – 200 East*, RPP-8321, Three Rivers Scientific, West Richland, Washington.

U.S. Department of Energy (DOE), 1997. *Vadose Zone Characterization Project at the Hanford Tank Farms, Tank Summary Data Report for Tank C-106*, GJ-HAN-84, prepared by MACTEC-ERS for the Grand Junction Office, Grand Junction, Colorado.

__________, 1998. *Hanford Tank Farms Vadose Zone, C Tank Farm Report*, GJO-98-39-TAR, GJO-HAN-18, prepared by MACTEC-ERS for the Grand Junction Office, Grand Junction, Colorado.

U.S. Department of Energy (DOE), 2000. *Hanford Tank Farms Vadose Zone, Addendum to the C Tank Farm Report*, GJO-98-39-TARA, GJO-HAN-18, prepared by MACTEC-ERS for the Grand Junction Office, Grand Junction, Colorado.

Washington State Department of Ecology, 1992. *241-C-106 Waste Tank Investigation*, prepared by Department of Ecology Nuclear and Mixed Waste Management RCRA Unit, Kennewick, Washington.

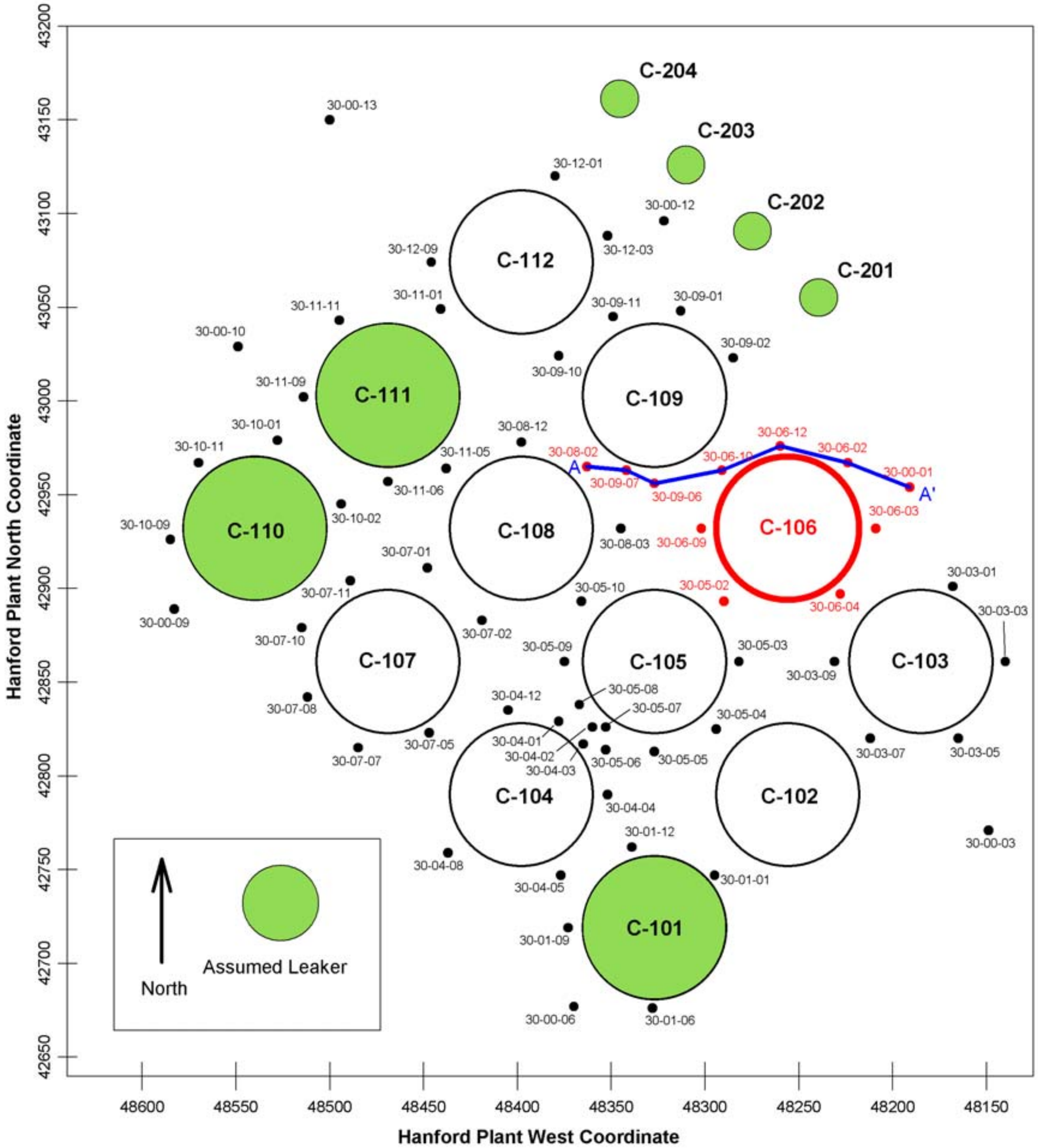

C-204
C-203
C-202
C-201
C-112
C-111
C-109
C-110
C-108
C-106
C-107
C-105
C-103
C-104
C-102
C-101
A
A'
North
Assumed Leaker
Hanford Plant North Coordinate
Hanford Plant West Coordinate

Figure 1

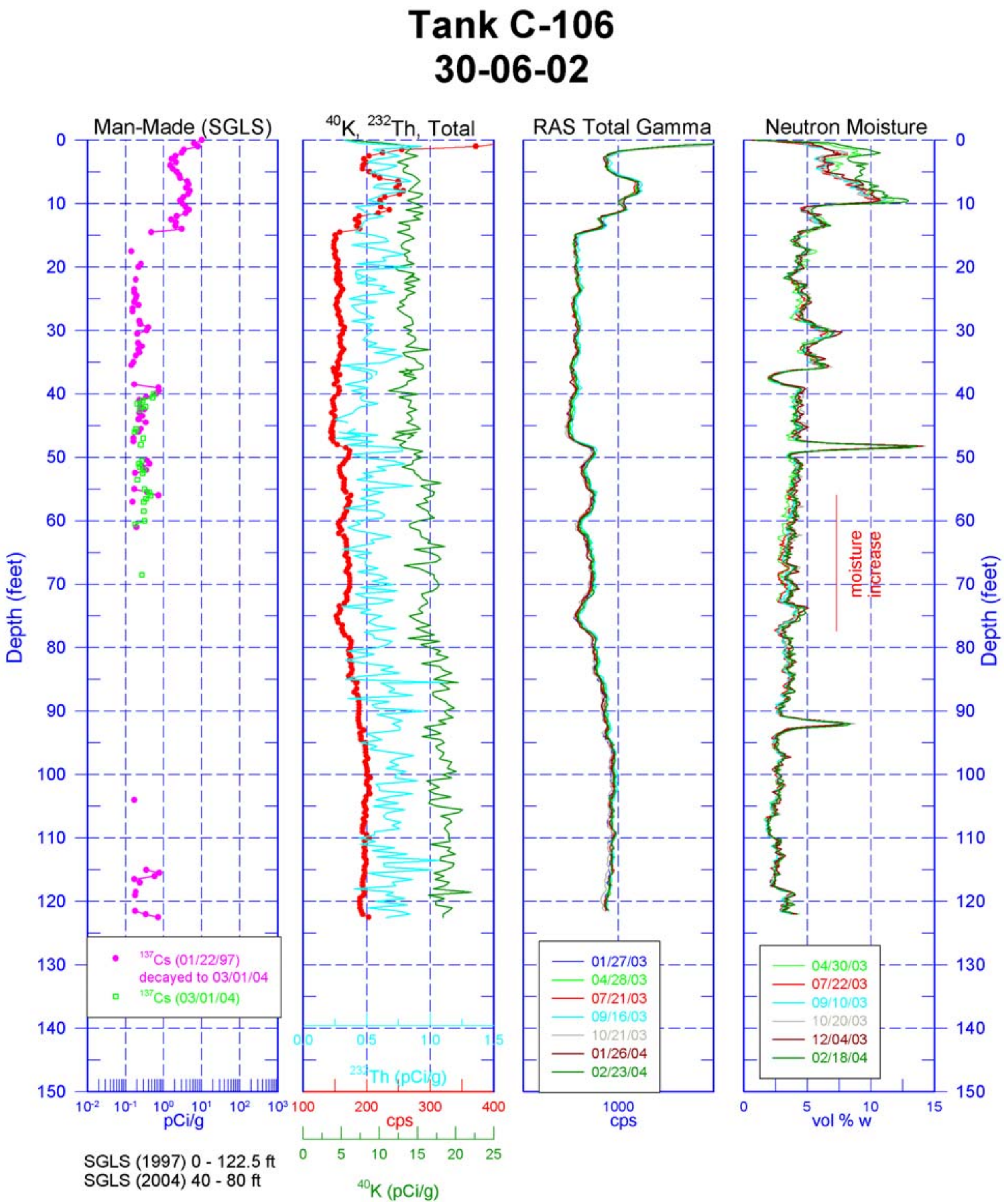

Tank C-106
30-06-02
Man-Made (SGLS)
40K, 232Th, Total
RAS Total Gamma
Neutron Moisture
Depth (feet)
137Cs (01/22/97) decayed to 03/01/04
137Cs (03/01/04)
pCi/g
SGLS (1997) 0 - 122.5 ft
SGLS (2004) 40 - 80 ft
232Th (pCi/g)
cps
40K (pCi/g)
01/27/03
04/28/03
07/21/03
09/16/03
10/21/03
01/26/04
02/23/04
moisture increase
04/30/03
07/22/03
09/10/03
10/20/03
12/04/03
02/18/04
vol % w

Figure 2a

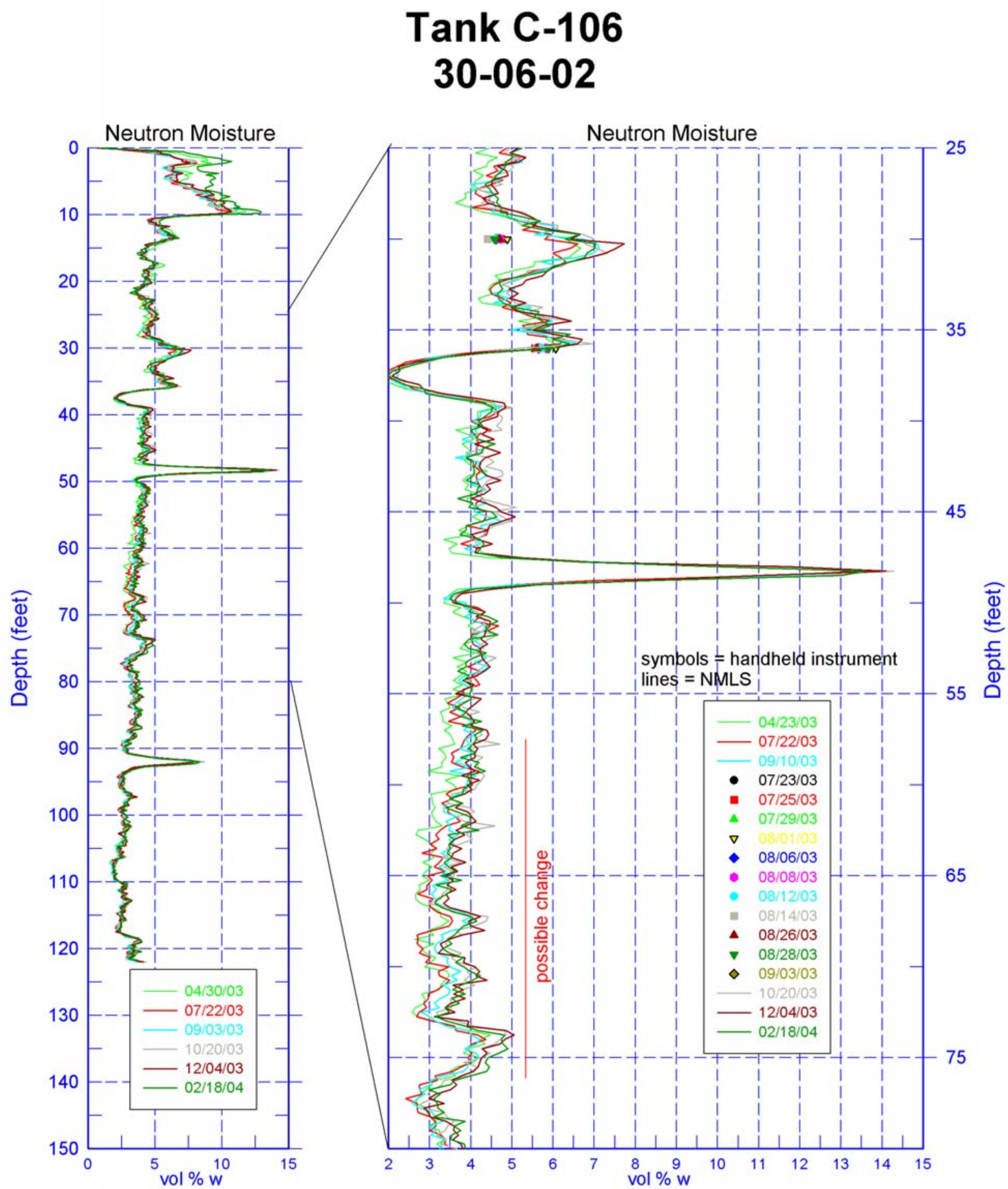

Tank C-106
30-06-02
Neutron Moisture
Depth (feet)
vol % w
04/30/03
07/22/03
09/03/03
10/20/03
12/04/03
02/18/04
Neutron Moisture
symbols = handheld instrument
lines = NMLS
possible change
04/23/03
07/22/03
09/10/03
07/23/03
07/25/03
07/29/03
08/01/03
08/06/03
08/08/03
08/12/03
08/14/03
08/26/03
08/28/03
09/03/03
10/20/03
12/04/03
02/18/04

Figure 2b

Tank C-106
30-06-03

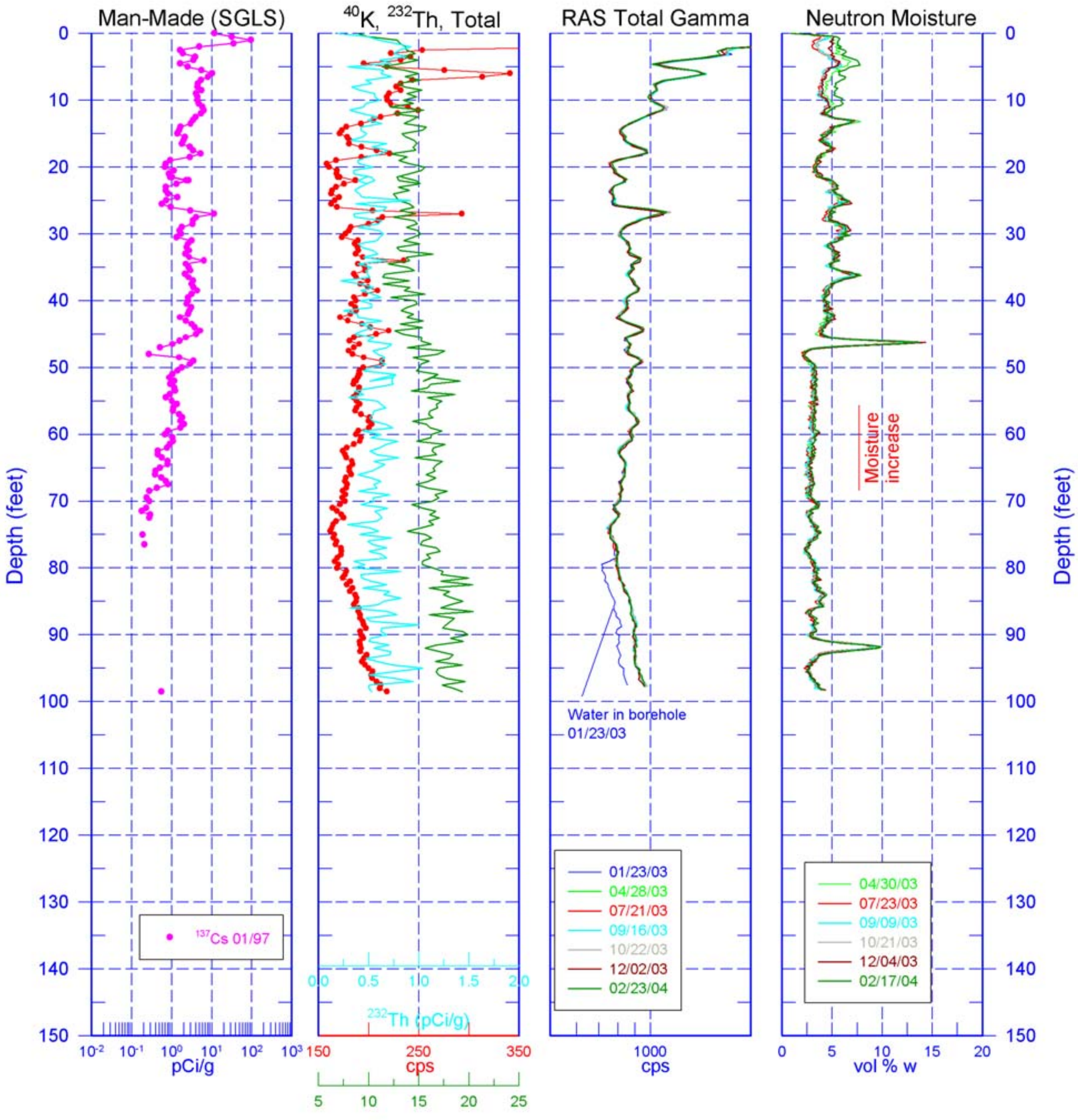
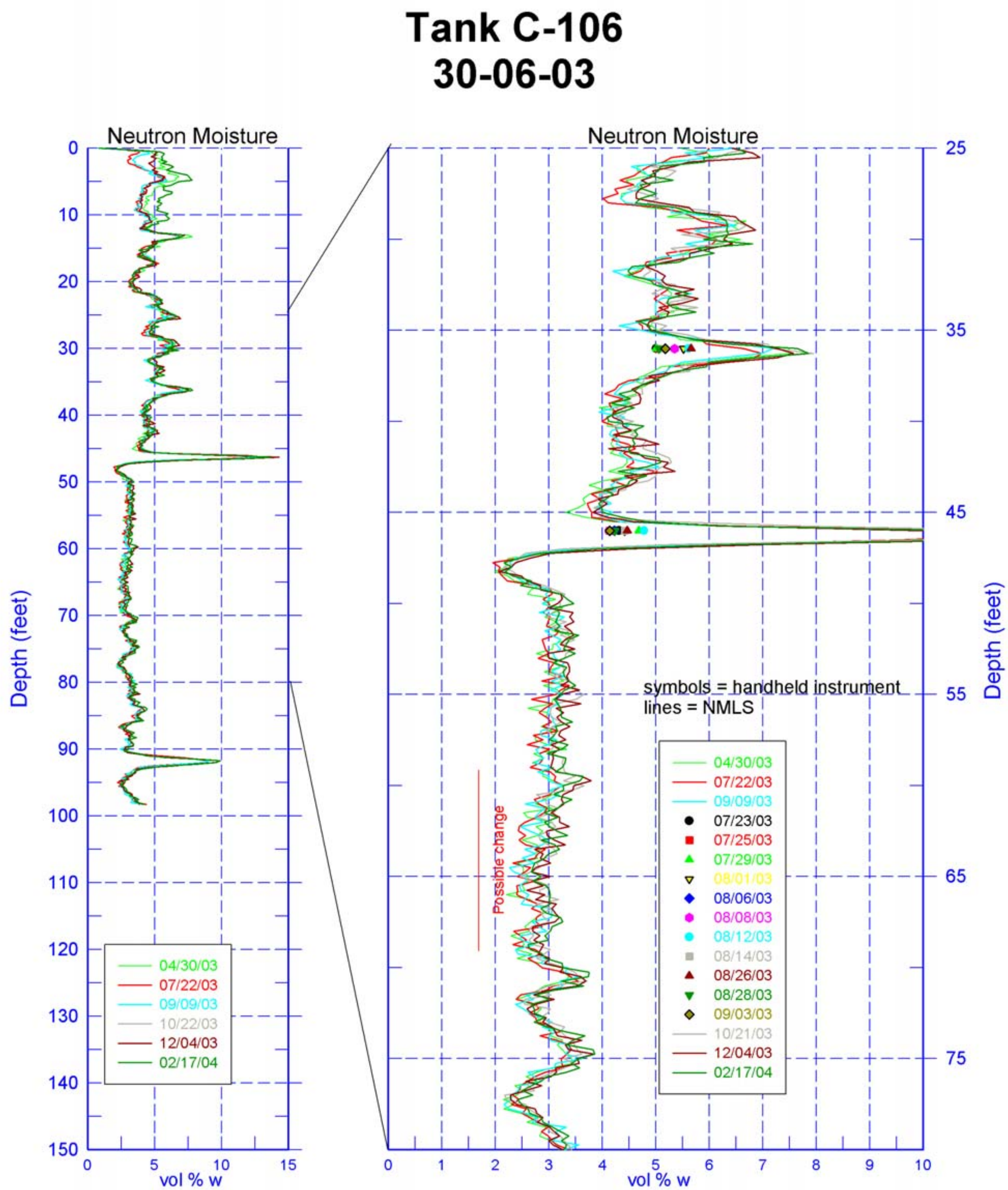


Figure 3a



Tank C-106
30-06-03
Neutron Moisture
Neutron Moisture
Depth (feet)
Depth (feet)
vol % w
vol % w
04/30/03
07/22/03
09/09/03
10/22/03
12/04/03
02/17/04
symbols = handheld instrument
lines = NMLS
04/30/03
07/22/03
09/09/03
07/23/03
07/25/03
07/29/03
08/01/03
08/06/03
08/08/03
08/12/03
08/14/03
08/26/03
08/28/03
09/03/03
10/21/03
12/04/03
02/17/04
Possible change

Figure 3b

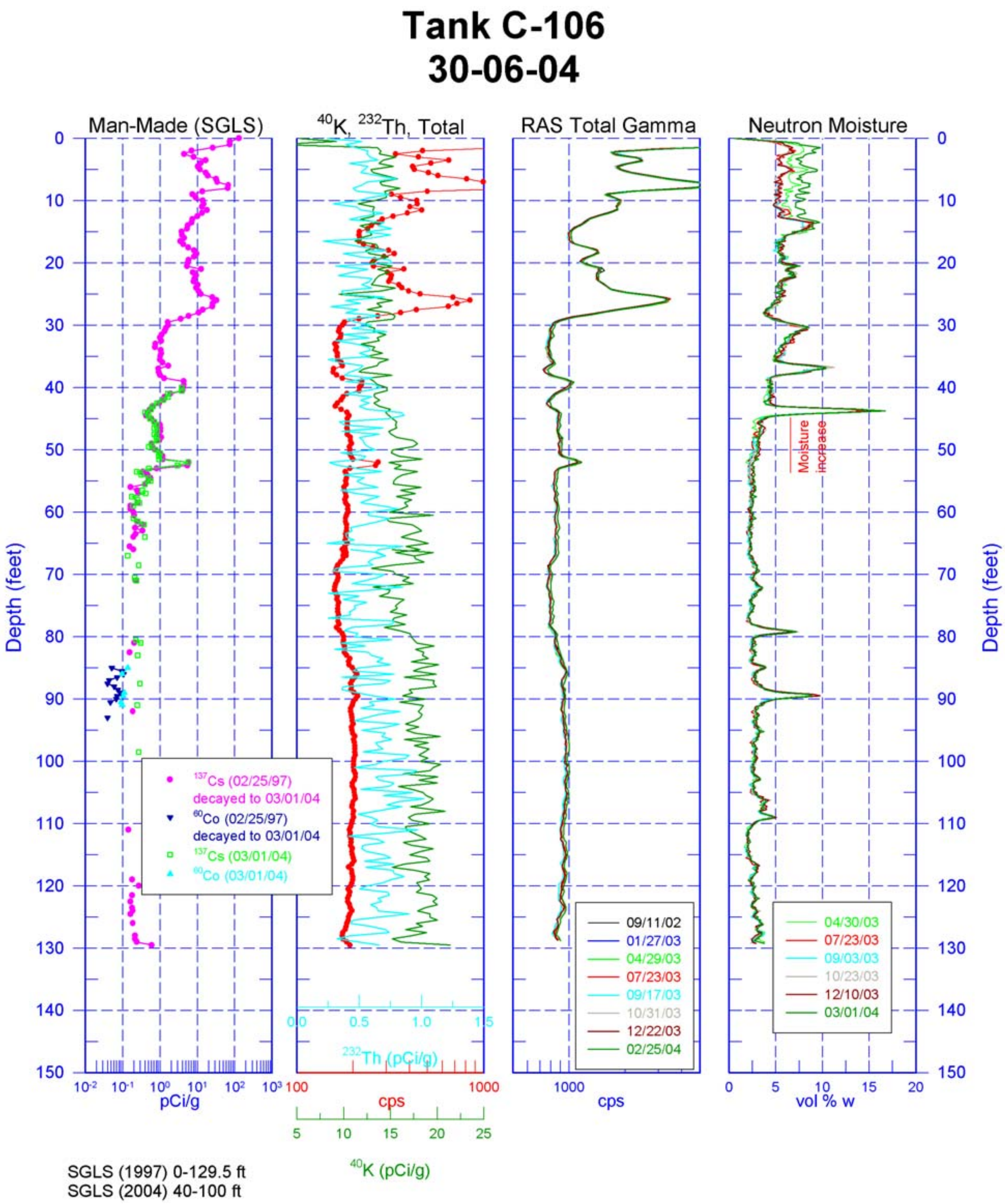

Tank C-106
30-06-04
Man-Made (SGLS)
40K, 232Th, Total
RAS Total Gamma
Neutron Moisture
Depth (feet)
137Cs (02/25/97) decayed to 03/01/04
60Co (02/25/97) decayed to 03/01/04
137Cs (03/01/04)
60Co (03/01/04)
232Th (pCi/g)
pCi/g
cps
cps
vol % w
40K (pCi/g)
Moisture increase
09/11/02
01/27/03
04/29/03
07/23/03
09/17/03
10/31/03
12/22/03
02/25/04
04/30/03
07/23/03
09/03/03
10/23/03
12/10/03
03/01/04
SGLS (1997) 0-129.5 ft
SGLS (2004) 40-100 ft

Figure 4a

Tank C-106
30-06-04

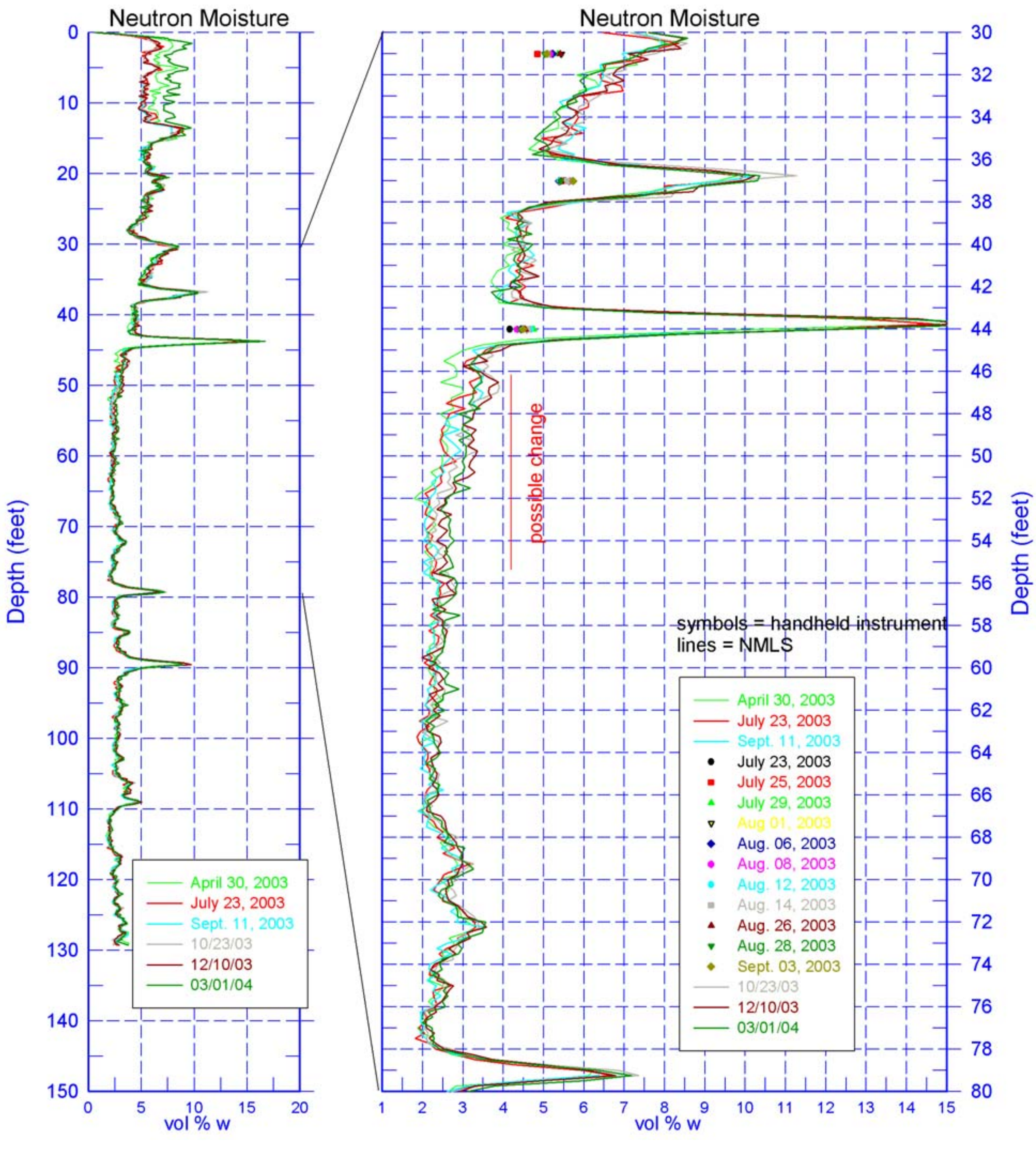


Figure 4b

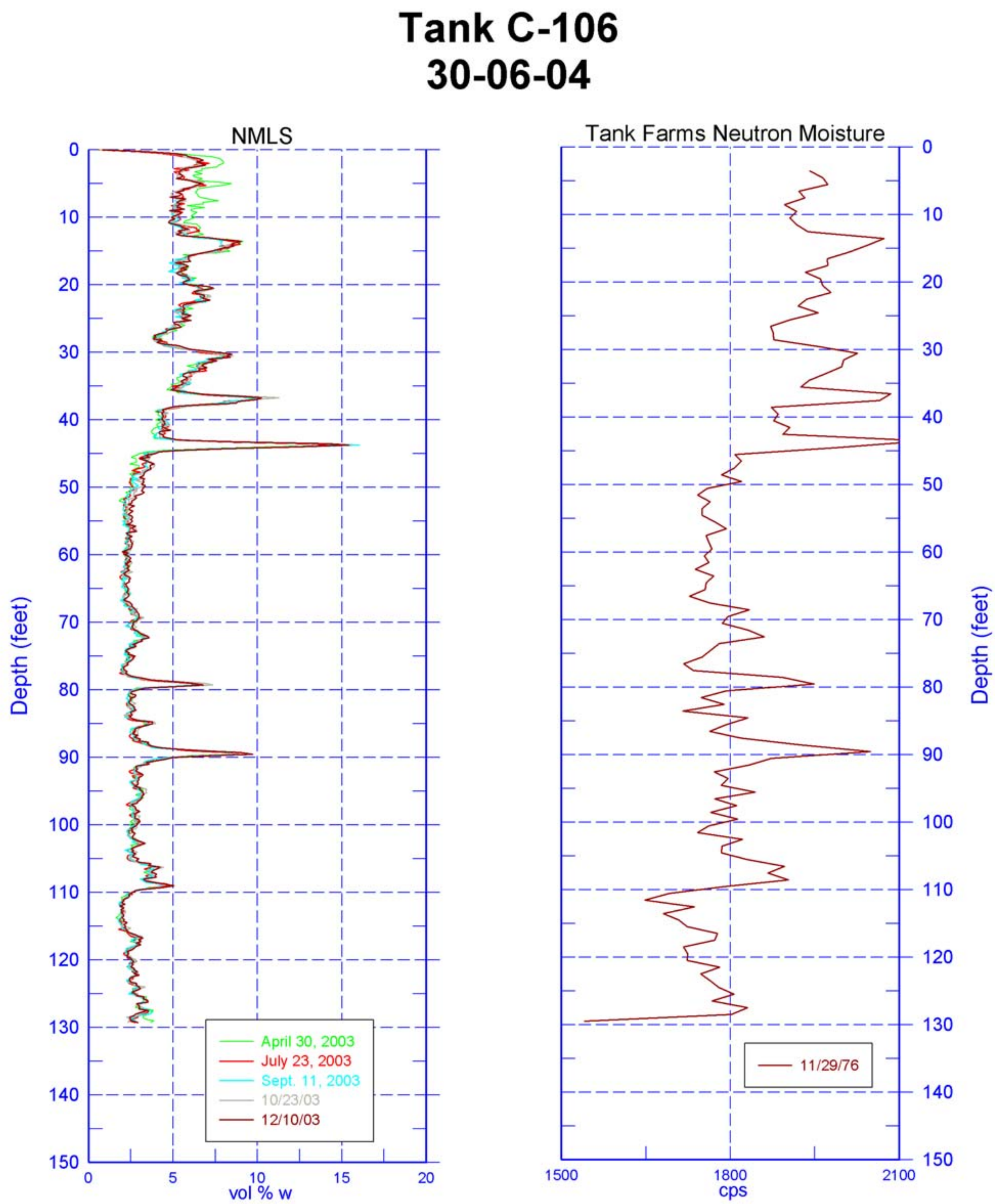

Tank C-106
30-06-04
NMLS
Tank Farms Neutron Moisture
Depth (feet)
vol % w
cps
April 30, 2003
July 23, 2003
Sept. 11, 2003
10/23/03
12/10/03
11/29/76

Figure 4c

Tank C-105
30-05-02

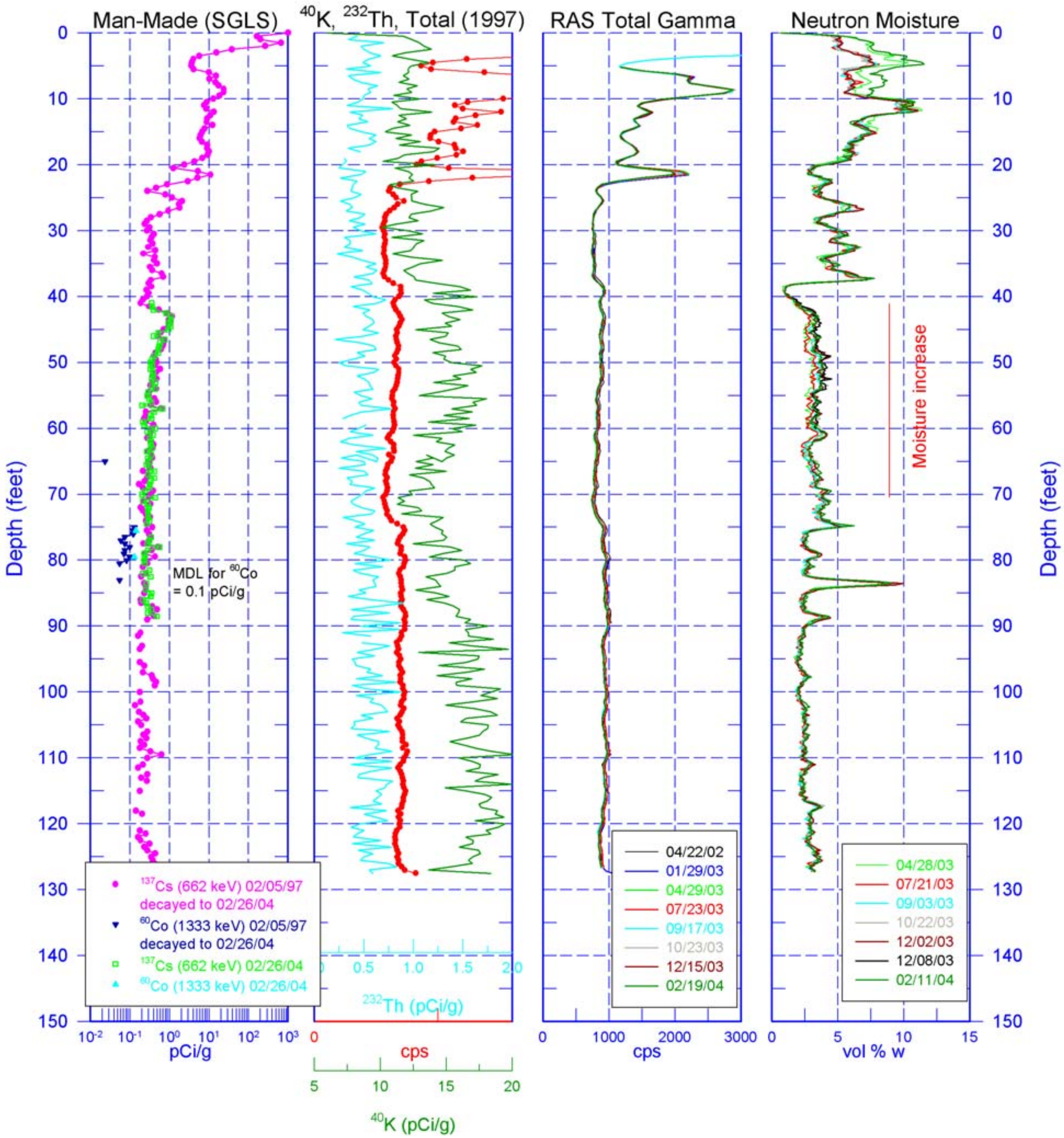


Figure 5a

Tank C-105
30-05-02

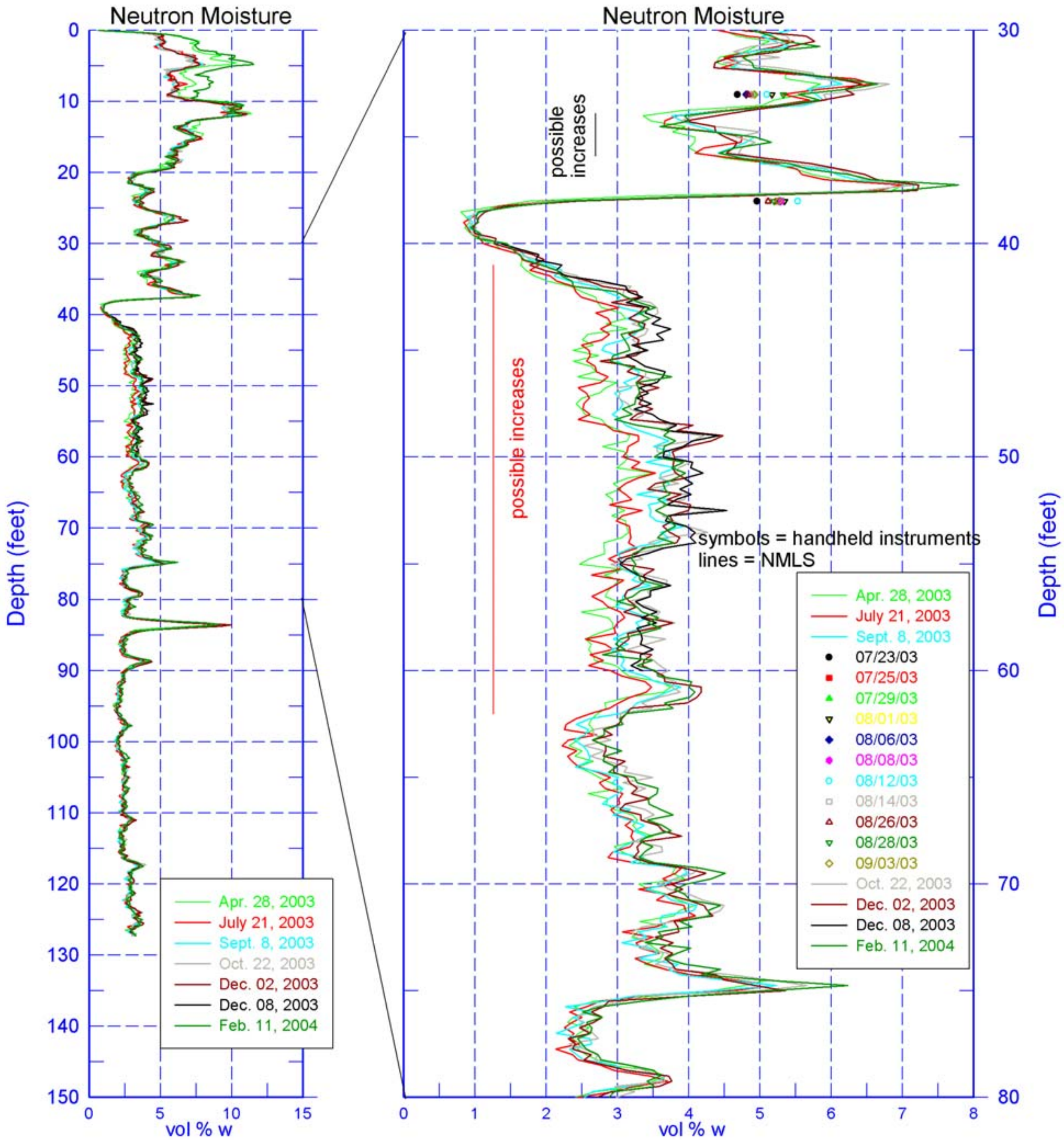
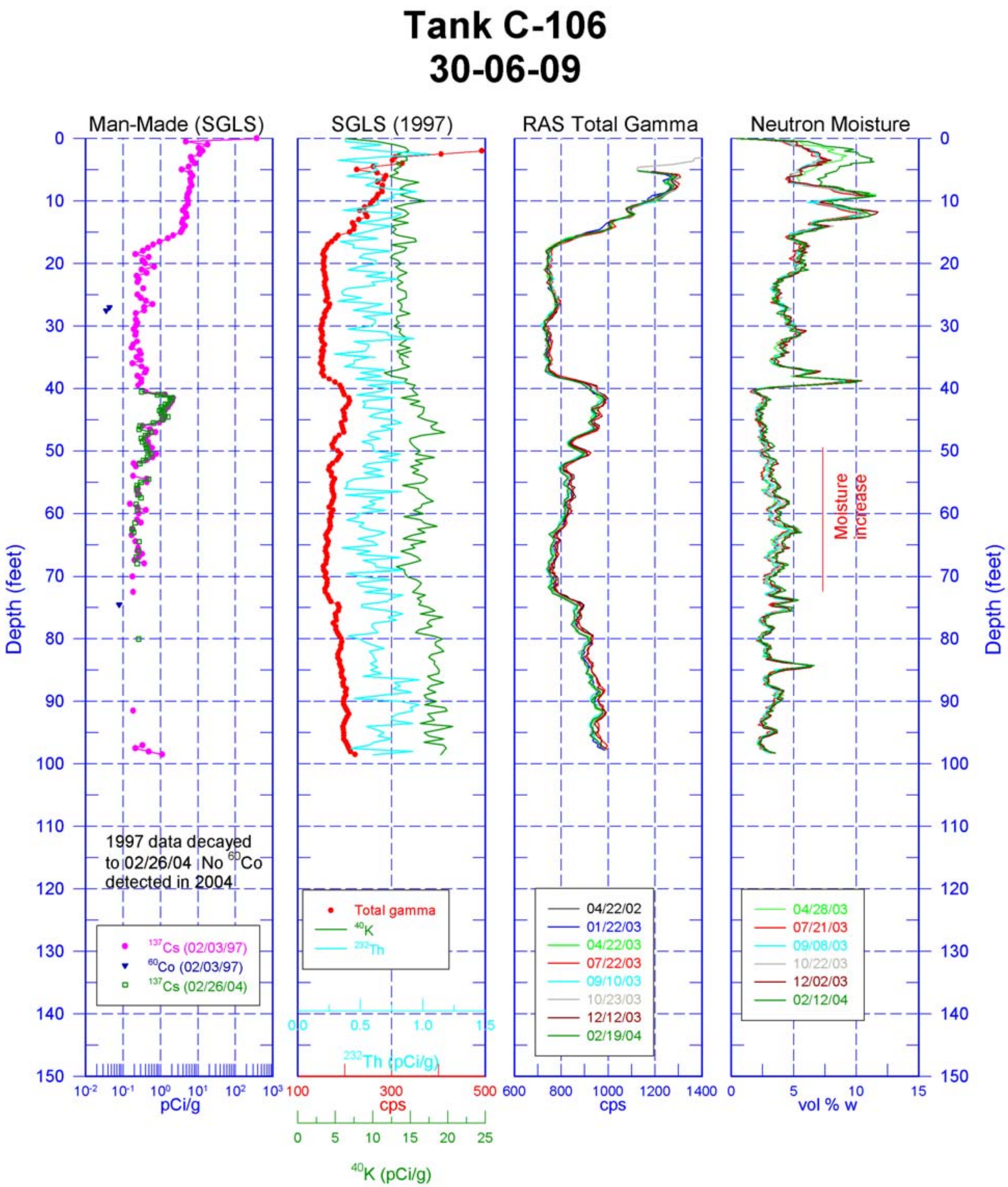


Figure 5b



Tank C-106
30-06-09
Man-Made (SGLS)
SGLS (1997)
RAS Total Gamma
Neutron Moisture
Depth (feet)
1997 data decayed to 02/26/04 No 60Co detected in 2004
137Cs (02/03/97)
60Co (02/03/97)
137Cs (02/26/04)
Total gamma
40K
232Th
04/22/02
01/22/03
04/22/03
07/22/03
09/10/03
10/23/03
12/12/03
02/19/04
04/28/03
07/21/03
09/08/03
10/22/03
12/02/03
02/12/04
Moisture increase
pCi/g
232Th (pCi/g)
cps
40K (pCi/g)
cps
vol % w

Figure 6a

Tank C-106
30-06-09

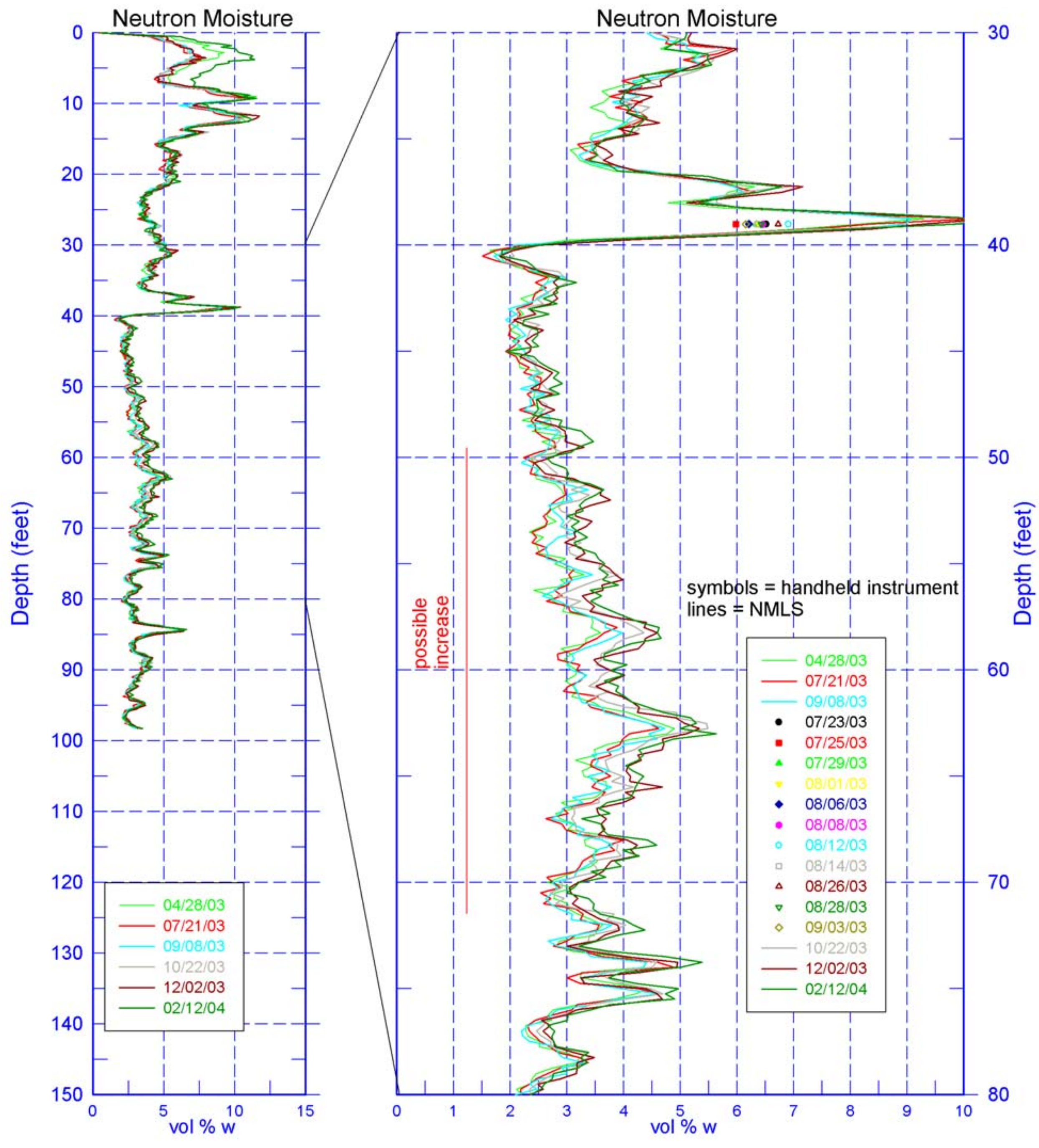
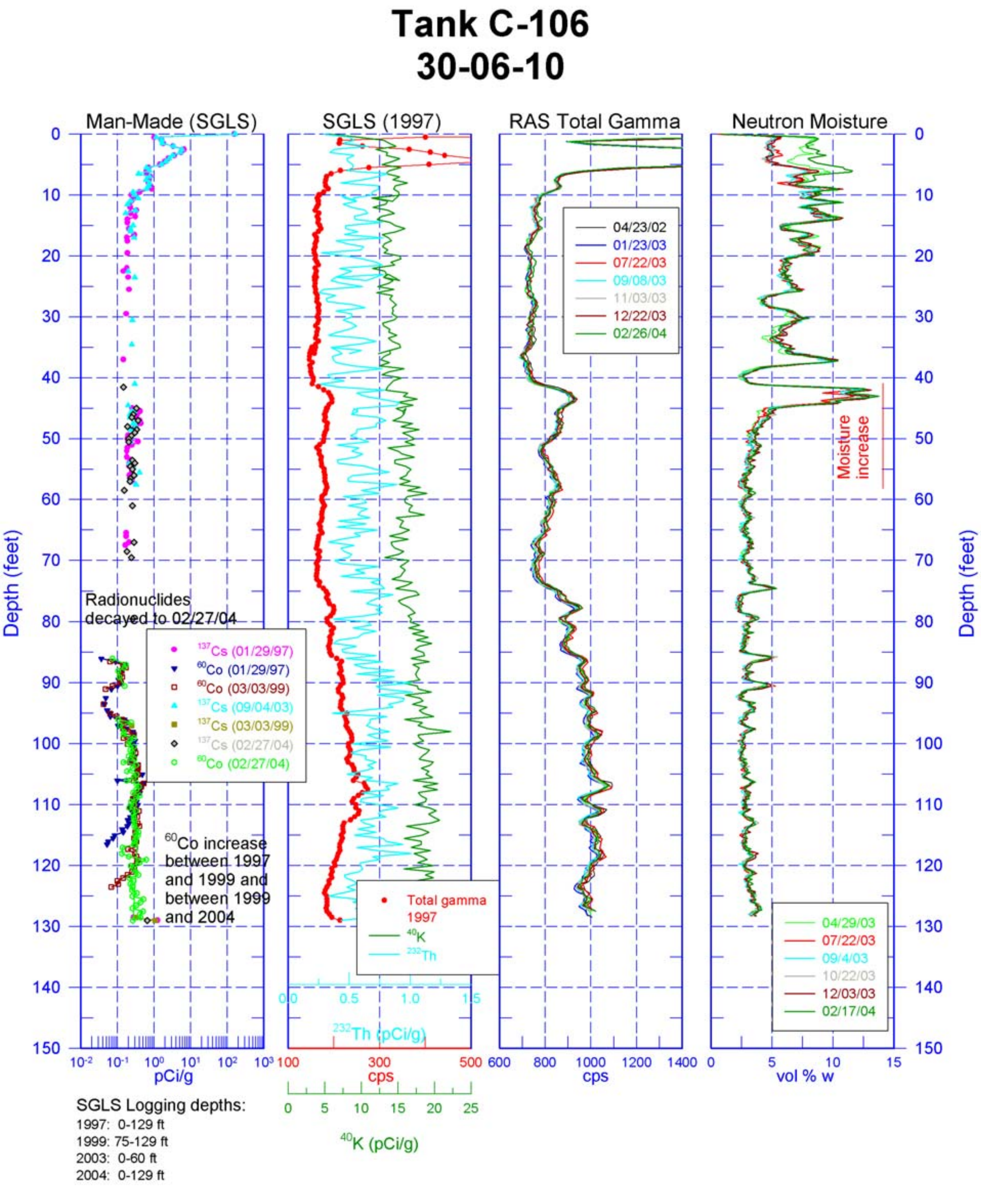


Figure 6b



Tank C-106
30-06-10
Man-Made (SGLS)
SGLS (1997)
RAS Total Gamma
Neutron Moisture
Depth (feet)
Radionuclides decayed to 02/27/04
137Cs (01/29/97)
60Co (01/29/97)
60Co (03/03/99)
137Cs (09/04/03)
137Cs (03/03/99)
137Cs (02/27/04)
60Co (02/27/04)
60Co increase between 1997 and 1999 and between 1999 and 2004
pCi/g
SGLS Logging depths:
1997: 0-129 ft
1999: 75-129 ft
2003: 0-60 ft
2004: 0-129 ft
Total gamma 1997
40K
232Th
232Th (pCi/g)
cps
40K (pCi/g)
04/23/02
01/23/03
07/22/03
09/08/03
11/03/03
12/22/03
02/26/04
Moisture increase
04/29/03
07/22/03
09/4/03
10/22/03
12/03/03
02/17/04
vol % w

Figure 7a

Tank C-106
30-06-10

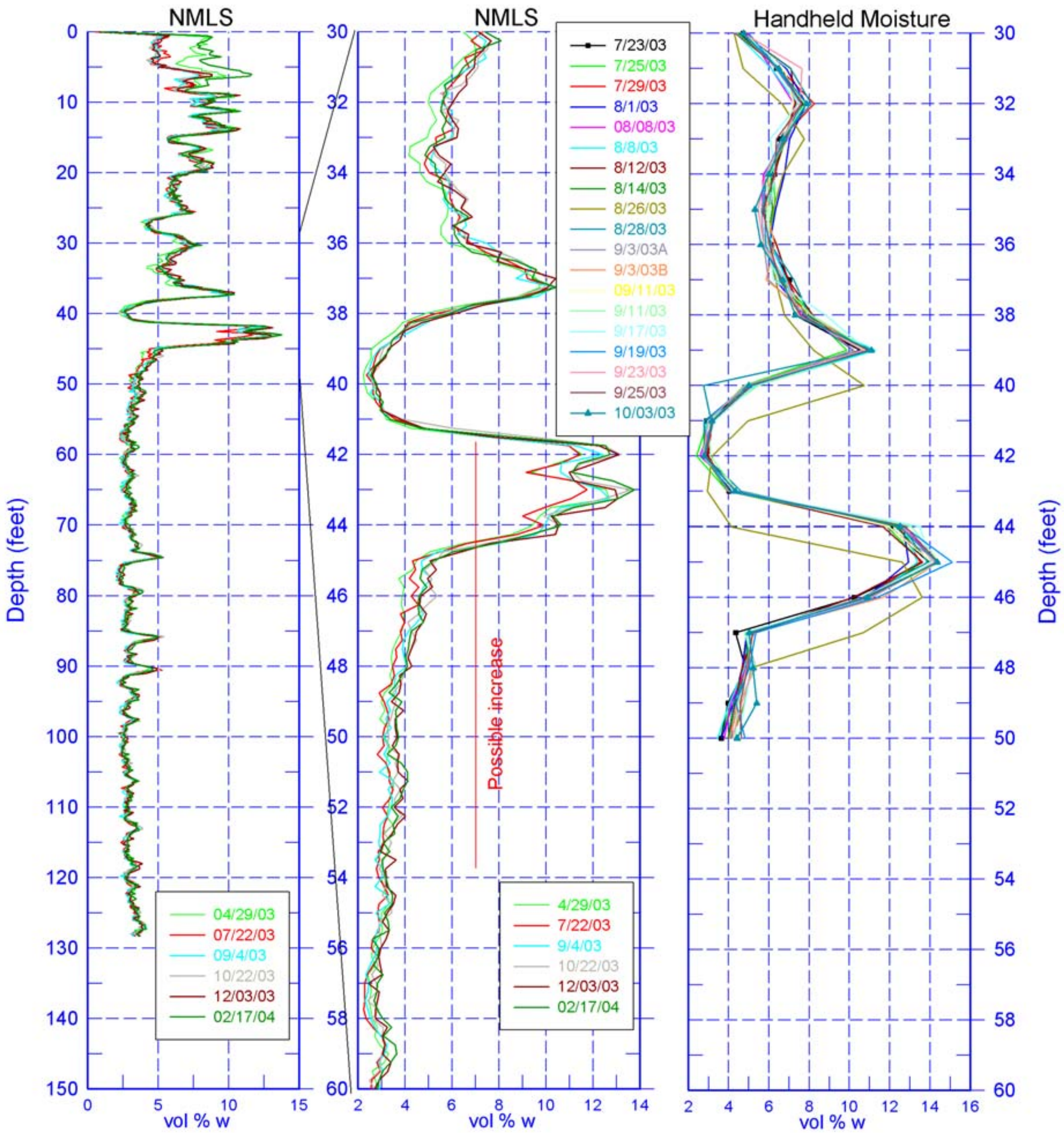


Figure 7b

Tank C-106
30-06-12

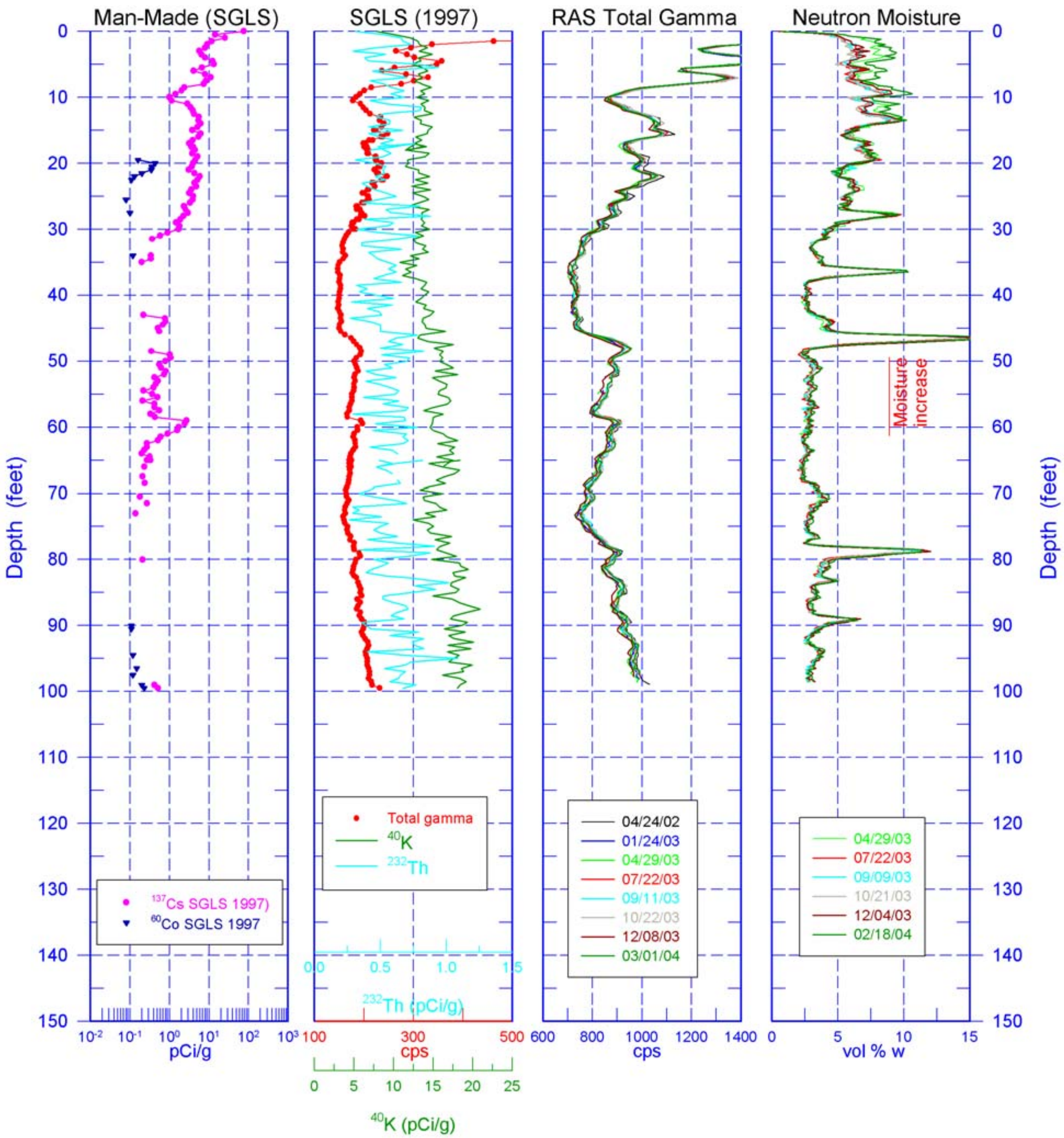


Figure 8a

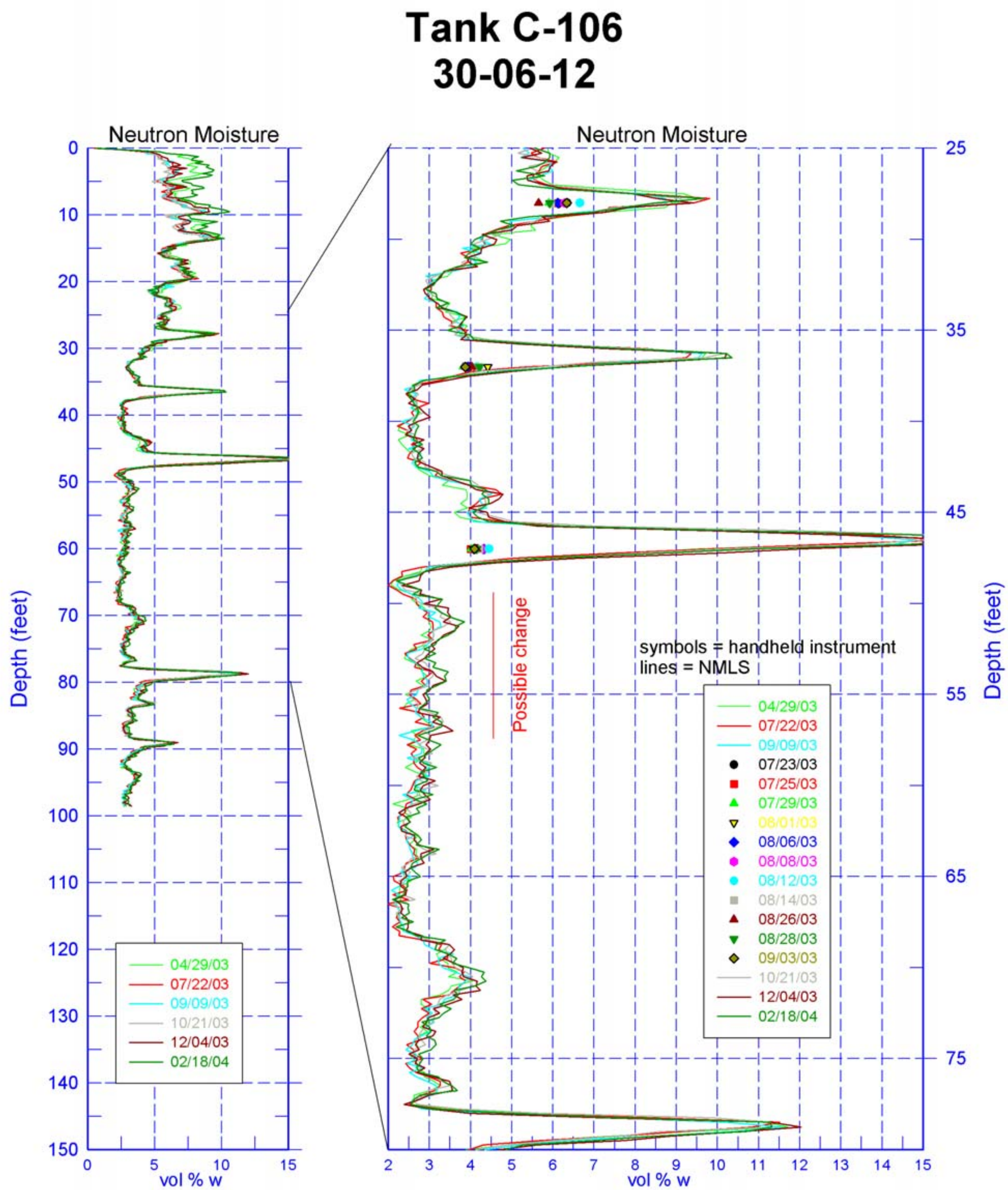

Tank C-106
30-06-12
Neutron Moisture
Neutron Moisture
Depth (feet)
Depth (feet)
vol % w
vol % w
Possible change
symbols = handheld instrument
lines = NMLS
04/29/03
07/22/03
09/09/03
07/23/03
07/25/03
07/29/03
08/01/03
08/06/03
08/08/03
08/12/03
08/14/03
08/26/03
08/28/03
09/03/03
10/21/03
12/04/03
02/18/04

Figure 8b

Tank C-108
30-08-02

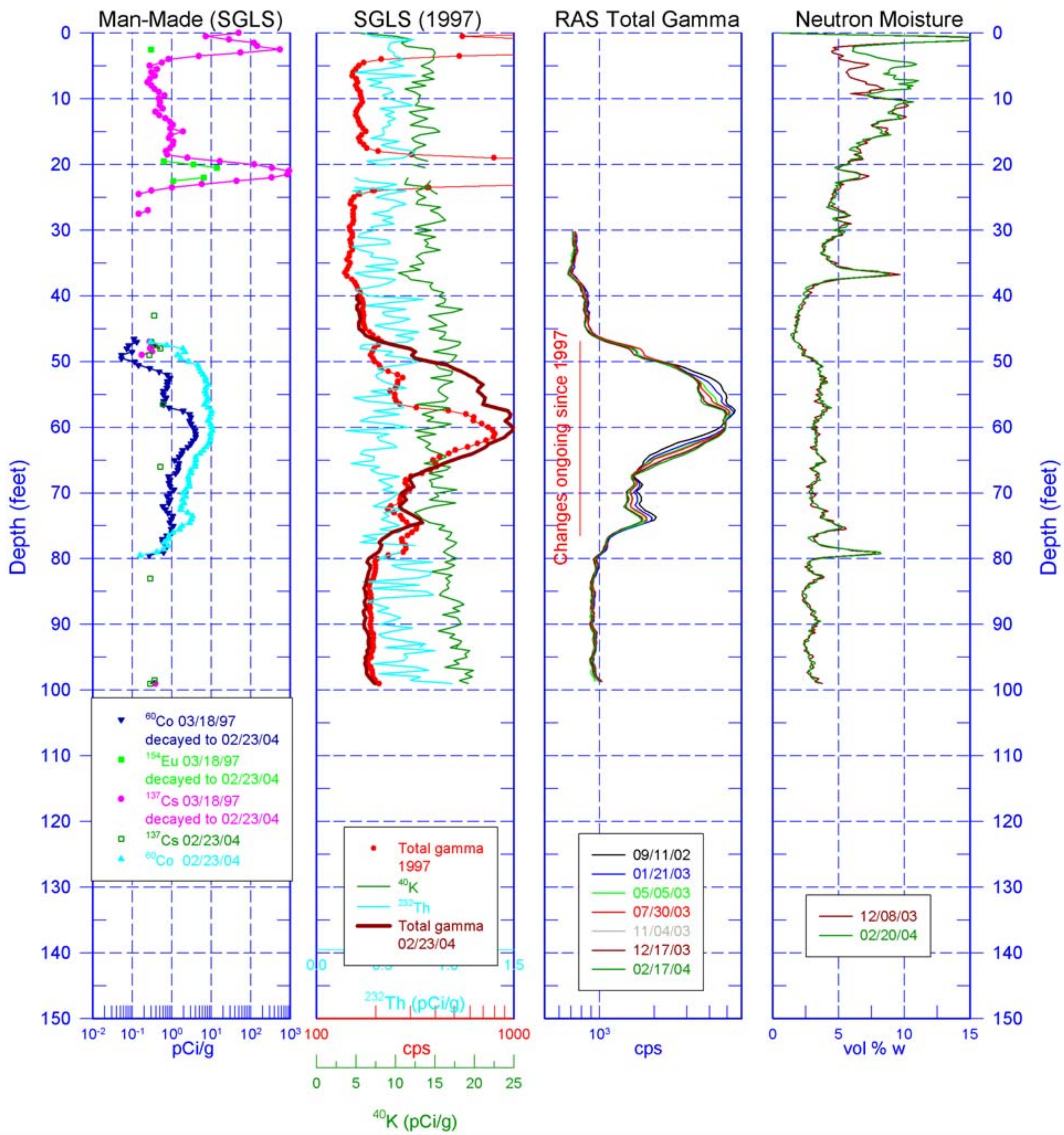


Figure 9a

Tank C-108
30-08-02

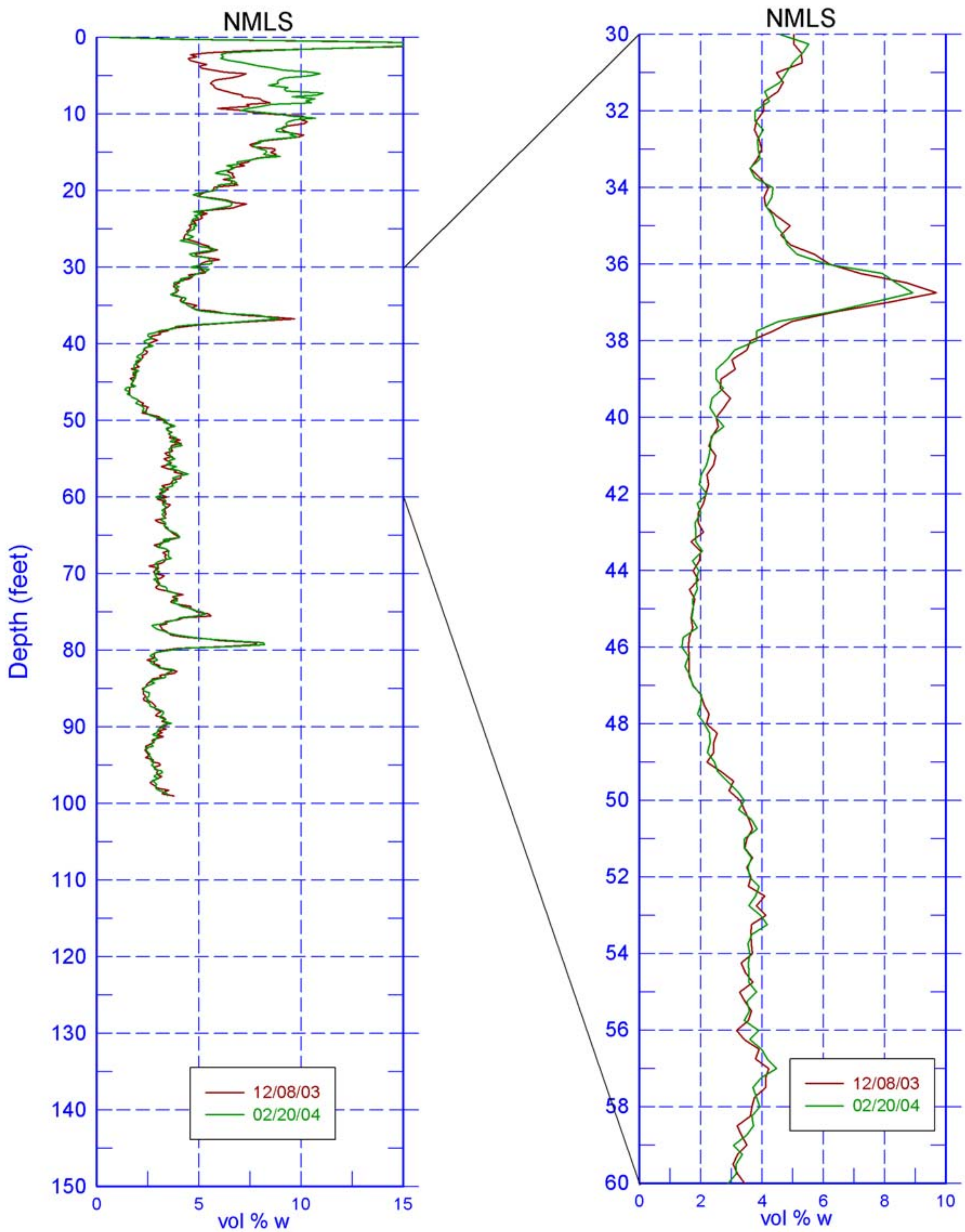
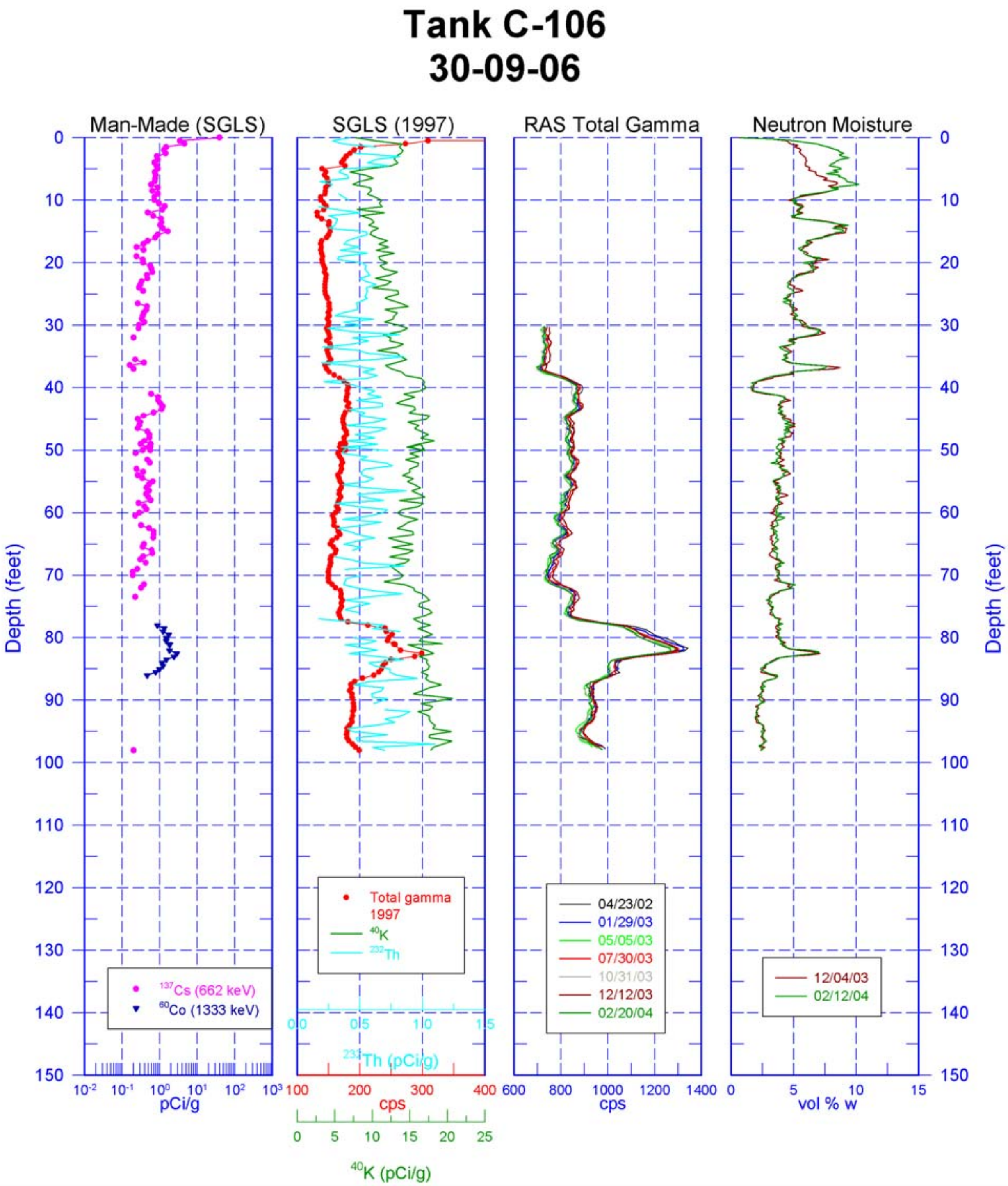


Figure 9b



Tank C-106
30-09-06
Man-Made (SGLS)
SGLS (1997)
RAS Total Gamma
Neutron Moisture
Depth (feet)
137Cs (662 keV)
60Co (1333 keV)
pCi/g
Total gamma 1997
40K
232Th
232Th (pCi/g)
cps
40K (pCi/g)
04/23/02
01/29/03
05/05/03
07/30/03
10/31/03
12/12/03
02/20/04
12/04/03
02/12/04
vol % w

Figure 10a

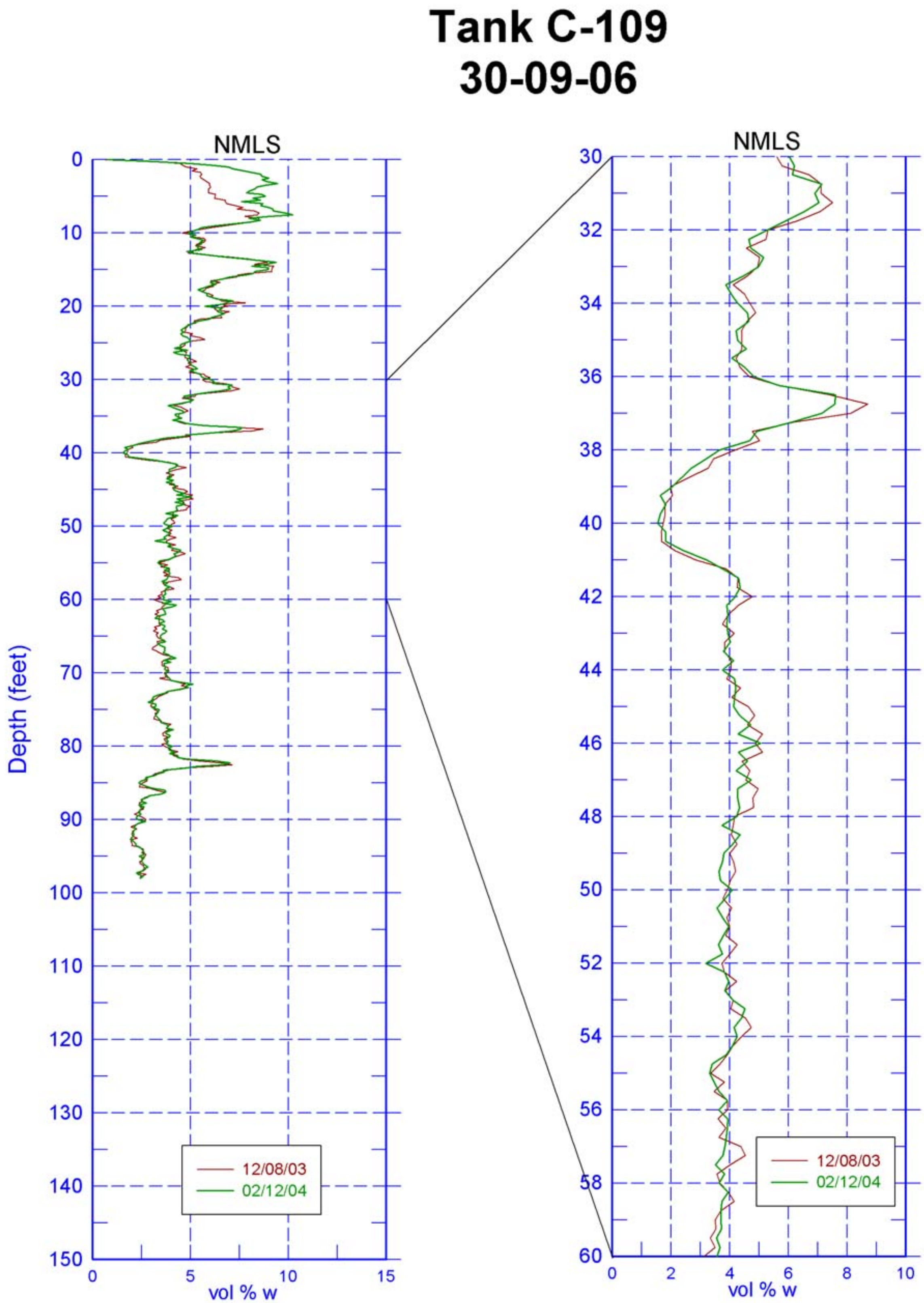

Tank C-109
30-09-06
NMLS
Depth (feet)
vol % w
12/08/03
02/12/04
NMLS
vol % w
12/08/03
02/12/04

Figure 10b

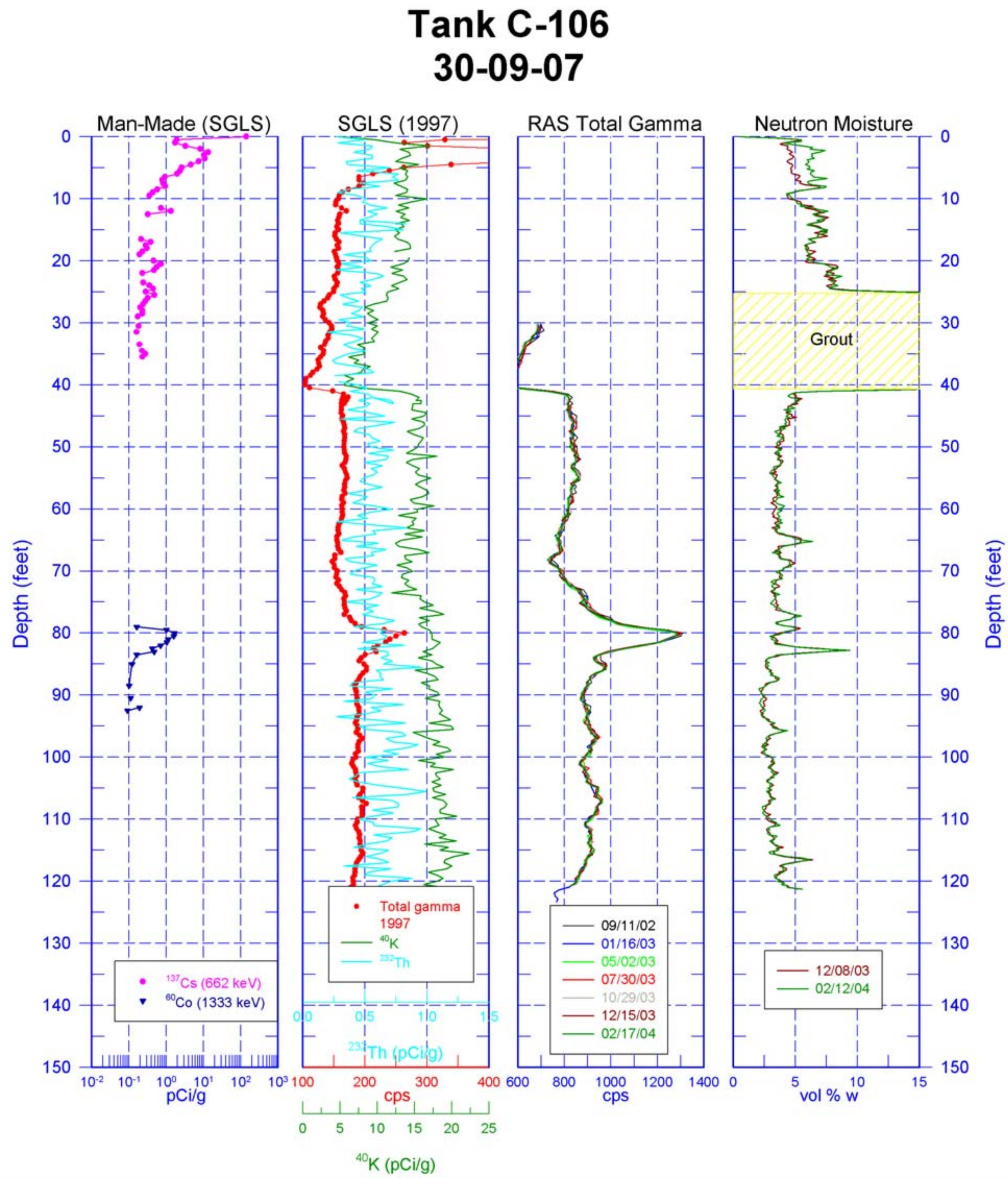
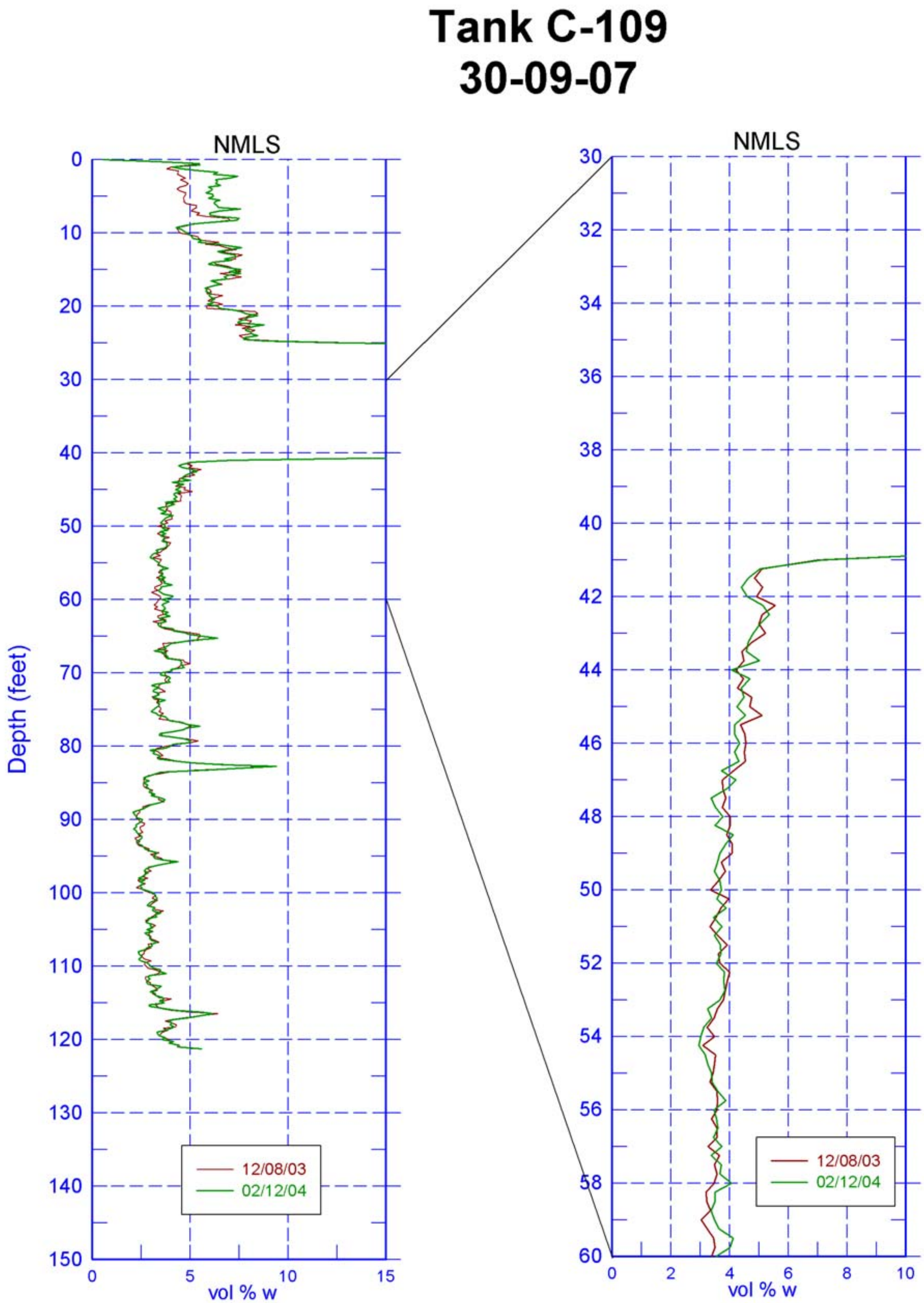
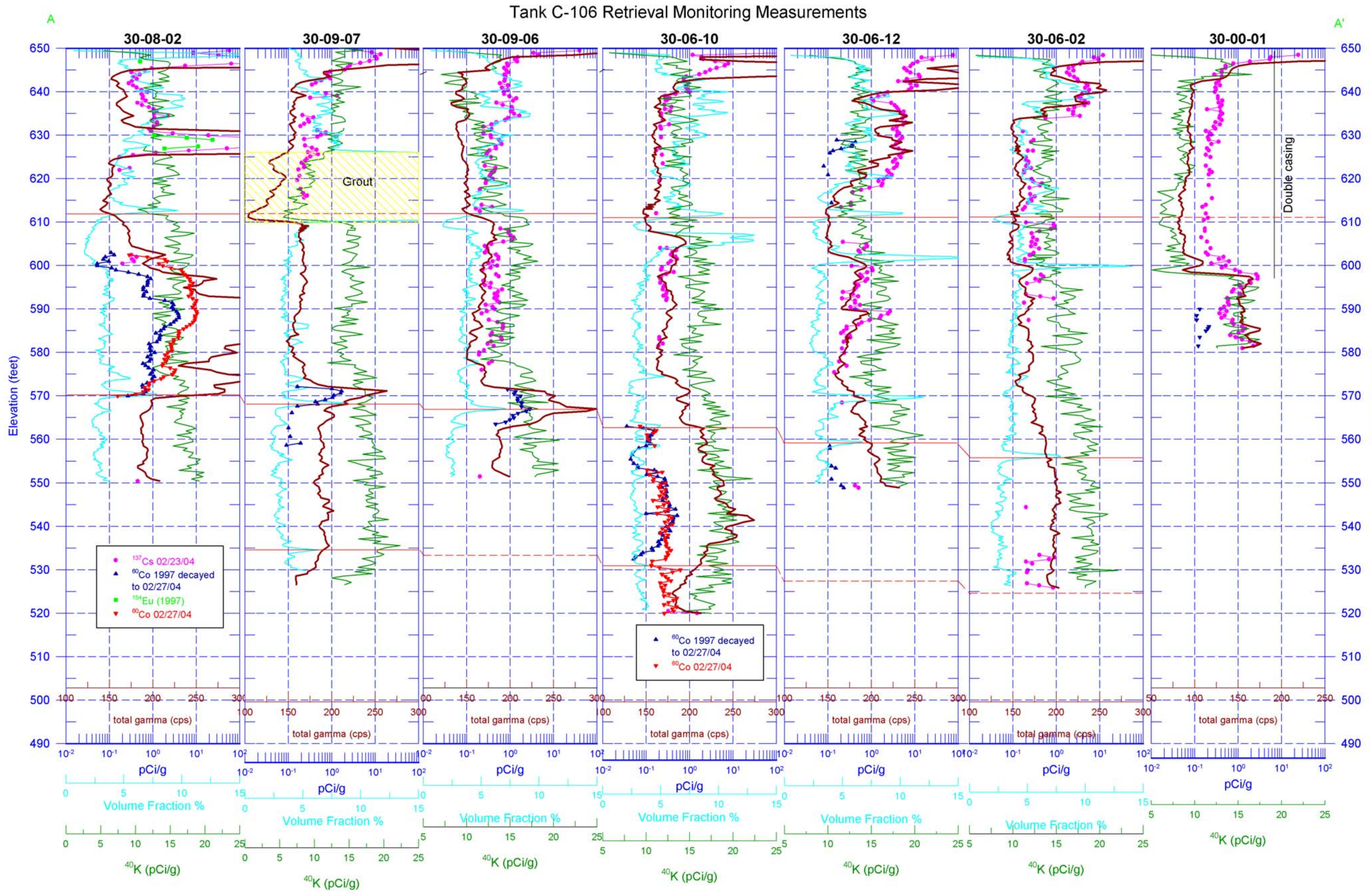

Tank C-106
30-09-07
Man-Made (SGLS)
SGLS (1997)
RAS Total Gamma
Neutron Moisture
Depth (feet)
Grout
Total gamma 1997
40K
232Th
137Cs (662 keV)
60Co (1333 keV)
09/11/02
01/16/03
05/02/03
07/30/03
10/29/03
12/15/03
02/17/04
12/08/03
02/12/04
pCi/g
cps
232Th (pCi/g)
40K (pCi/g)
vol % w

Figure 11a



Tank C-109
30-09-07
NMLS
Depth (feet)
vol % w
12/08/03
02/12/04
NMLS
vol % w
12/08/03
02/12/04

Figure 11b



Tank C-106 Retrieval Monitoring Measurements
A
A'
30-08-02
30-09-07
30-09-06
30-06-10
30-06-12
30-06-02
30-00-01
Grout
Double casing
Elevation (feet)
total gamma (cps)
pCi/g
Volume Fraction %
40K (pCi/g)
137Cs 02/23/04
60Co 1997 decayed to 02/27/04
154Eu (1997)
60Co 02/27/04

Figure 12

Appendix E
Tank S-112 Retrieval Monitoring
Log Plots

Borehole Number (Alias): 40-11-08 (299-W23-207) (A8043)

Borehole Information

Site: S Farm, Tank S-111			
Coordinates (HAN Plant):	**North: 35900**	**West: 75815**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: 134403.286**	**East: 566786.133**	**Elevation (m): 203.43**
Drill Date: 3/31/1976	**Type: Cable Tool**	**Depth (ft): 97.5**	**Depth Datum: TOC**
Depth/Water (ft): 96.75	**D/W Date: 2/4/04**	**D/W Reference: Stoller**	

Comments: The upper 20 ft of this borehole are grout and the bottom of the borehole was filled with grout.

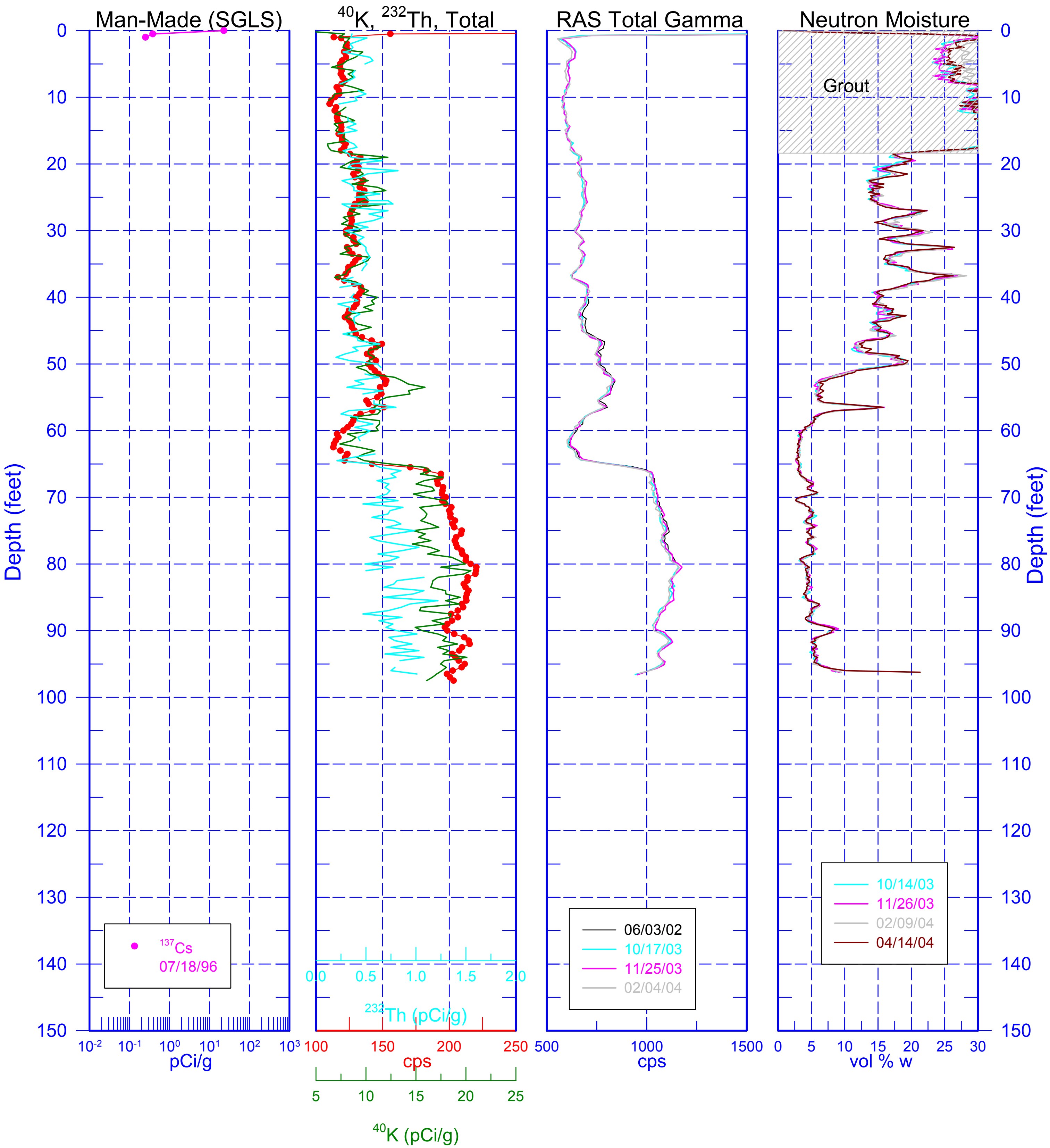
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
07/18/96	SGLS	G2A	NA	0-97.5	MACTEC-ERS	Baseline
06/03/02	RAS	Large	A	40-80	MACTEC-ERS	No Change
10/14/03	NMLS	Moisture	1	0-96.25	Stoller	Moisture Baseline
10/17/03	RAS	Large-New	B	0-97	Stoller	No Change
11/25/03	RAS	Large-New	C	0-97	Stoller	No Change
11/26/03	NMLS	Moisture	2	0-96.25	Stoller	No Change
02/04/04	RAS	Large-New	D	0-97	Stoller	No Change
02/09/04	NMLS	Moisture	3	0-96.25	Stoller	No Change
4/14/2004	NMLS	Moisture	4	0-96.25	Stoller	No Change

Tank S-111
40-11-08



Stoller
Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-11-09 (299-W23-173) (A8008)

Borehole Information

Site: S Farm, Tank S-111			
Coordinates (HAN Plant):	**North: 35936**	**West: 75810**	**Elevation (ft): 663.91**
Coordinates (WA Plane):	**North: 134414.243**	**East: 566790.789**	**Elevation (m): 203.399**
Drill Date: 11/30/1971	**Type: Cable Tool**	**Depth (ft): 98.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 2/5/04**	**D/W Reference: Stoller**	
Comments: None.			

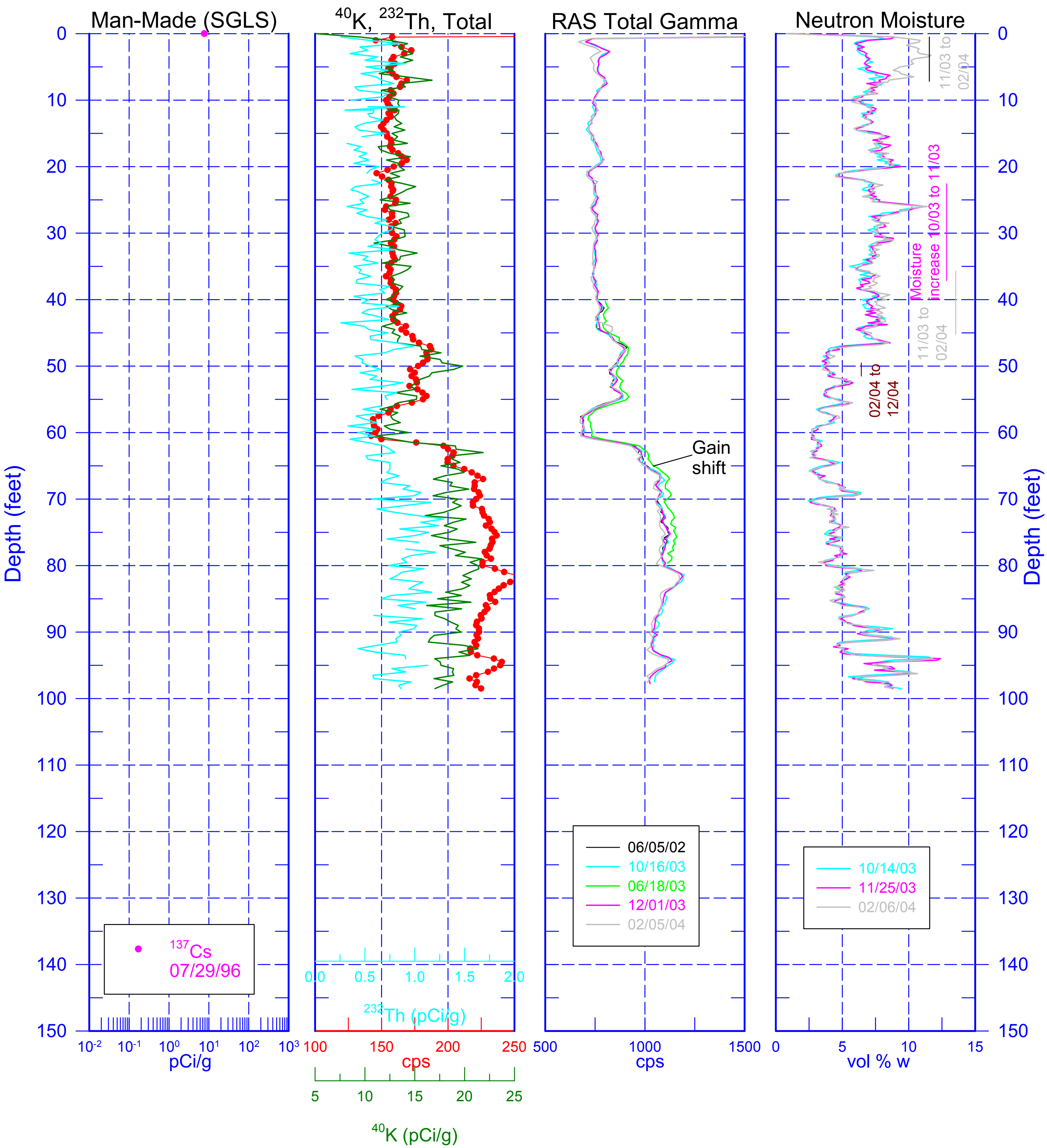
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
7/29/1996	SGLS	G1A	NA	0-98.5	MACTEC-ERS	Baseline
6/5/2002	RAS	Large	A	40-80	MACTEC-ERS	No Change
06/18/03	RAS	Large-New	B	40-80	Stoller	No Change
10/14/03	NMLS	Moisture	1	0-98.5	Stoller	Moisture Baseline
10/16/03	RAS	Large-New	C	0-98	Stoller	No Change
11/25/03	NMLS	Moisture	2	0-98.5	Stoller	Poss. Incr. 22-37 ft
12/01/03	RAS	Large-New	D	0-98	Stoller	No Change
02/05/04	RAS	Large-New	E	0-98	Stoller	No Change
02/06/04	NMLS	Moisture	3	0-98.5	Stoller	Poss. Incr. 36-45 & 0-7 ft.

Tank S-111
40-11-09



Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-12-02 (299-W23-174) (A8009)

Borehole Information

Site: S Farm, Tank S-112			
Coordinates (HAN Plant):	**North: 35952**	**West: 75837**	**Elevation (ft): 663.92**
Coordinates (WA Plane):	**North: 134419.130**	**East: 566782.572**	**Elevation (m): 203.400**
Drill Date: 10/31/1971	**Type: Cable Tool**	**Depth (ft): 99.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 2/5/04**	**D/W Reference: Stoller**	
Comments: None.			

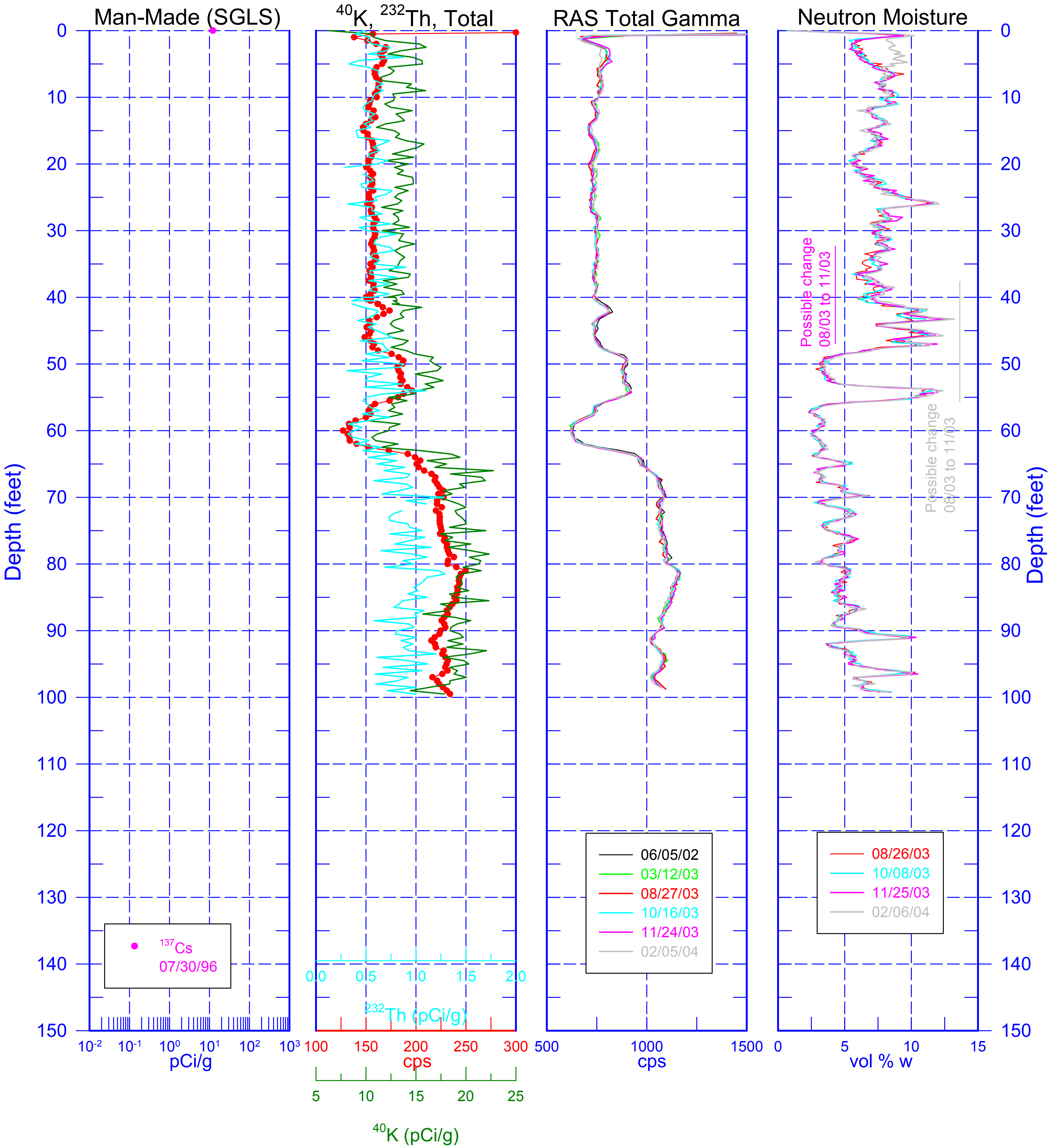
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
7/30/1996	SGLS	G1A	NA	0-99.5	MACTEC-ERS	Baseline
6/5/2002	RAS	Large	A	40-80	MACTEC-ERS	No Change
03/12/03	RAS	Large-New	B	0-99	Stoller	No Change
08/26/03	NMLS	Moisture	1	0-99.25	Stoller	Moisture Baseline
08/27/03	RAS	Large-New	C	0-99	Stoller	No Change
10/08/03	NMLS	Moisture	2	0-99.25	Stoller	No Change
10/16/03	RAS	Large-New	D	0-99	Stoller	No Change
11/24/03	RAS	Large-New	E	0-99	Stoller	No Change
11/25/03	NMLS	Moisture	3	0-99.25	Stoller	Poss. Incr. 32-47 ft.
02/05/04	RAS	Large-New	F	0-99	Stoller	No Change
02/06/04	NMLS	Moisture	4	0-99.25	Stoller	Poss. Incr. 38-55 ft.

Tank S-112
40-12-02



Stoller
Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-12-04 (299-W23-220) (A8050)

Borehole Information

Site: S Farm, Tank S-112			
Coordinates (HAN Plant):	**North: 35897**	**West: 75829**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: 134401.976**	**East: 566785.425**	**Elevation (m): 203.387**
Drill Date: 6/30/1978	**Type: Cable Tool**	**Depth (ft): 126**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 2/4/04**	**D/W Reference: Stoller**	
Comments: The top 20 ft of this borehole was grouted. The bottom of this borehole was filled with grout.			

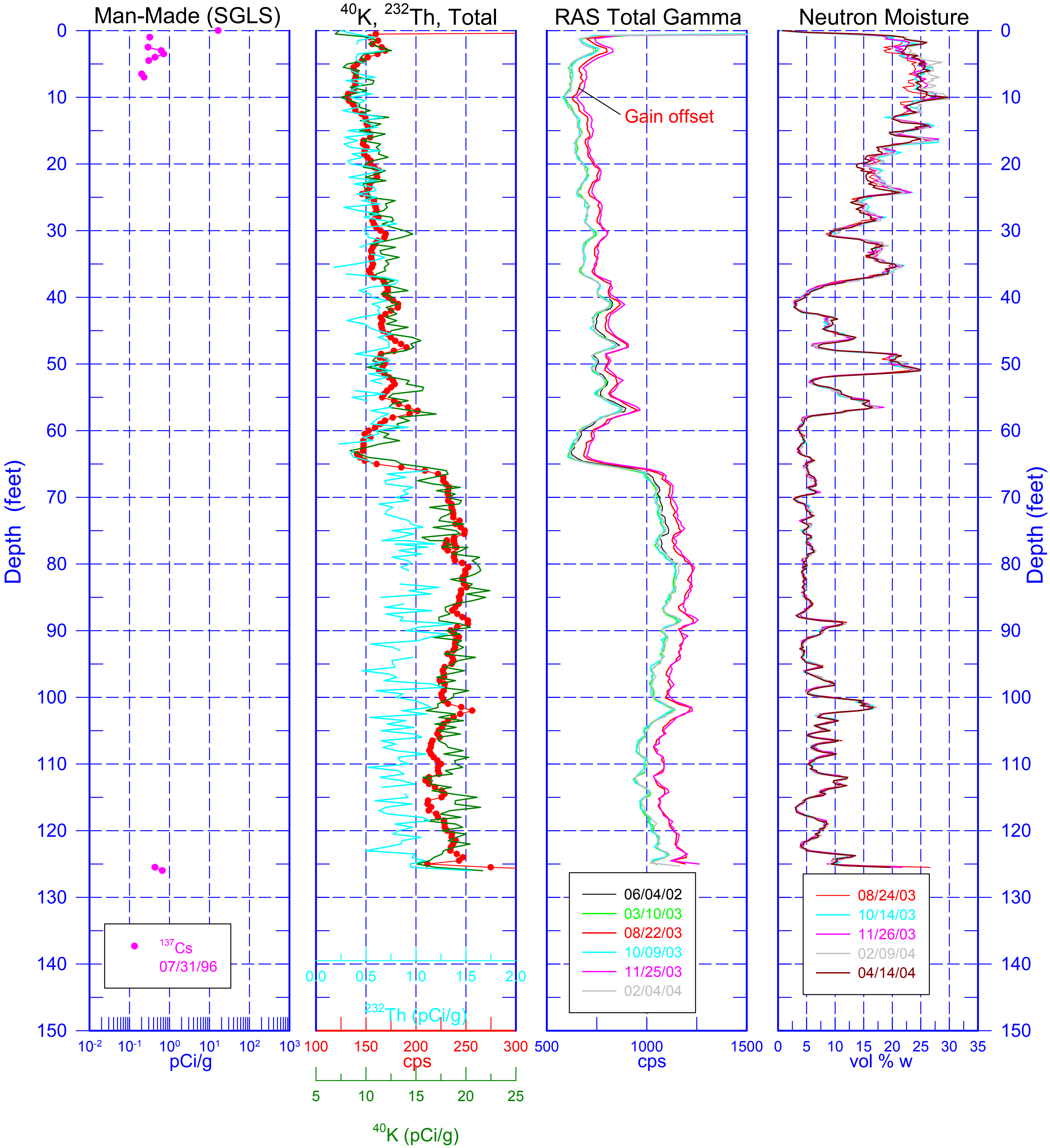
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	125	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
07/31/96	SGLS	G1A	NA	0-126	MACTEC-ERS	Baseline
06/04/02	RAS	Large	A	40-80	MACTEC-ERS	No Change
03/10/03	RAS	Large-New	B	0-126	Stoller	No Change
08/22/03	RAS	Large-New	C	0-126	Stoller	No Change (gain drift)
08/24/03	NMLS	Moisture	1	0-125.5	Stoller	Moisture Baseline
10/09/03	RAS	Large-New	D	0-126	Stoller	No Change
10/14/03	NMLS	Moisture	2	0-125.5	Stoller	No Change
11/25/03	RAS	Large-New	E	0-126	Stoller	No Change (gain drift)
11/26/03	NMLS	Moisture	3	0-125.5	Stoller	No Change
02/04/04	RAS	Large-New	F	0-126	Stoller	No Change
02/09/04	NMLS	Moisture	4	0-125.5	Stoller	No Change
04/14/04	NMLS	Moisture	5	0-125.5	Stoller	No Change

Tank S-112
40-12-04



Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-12-06 (299-W23-175) (A8011)

Borehole Information

Site: S Farm, Tank S-112			
Coordinates (HAN Plant):	**North: 35874**	**West: 75869**	**Elevation (ft): 663.43**
Coordinates (WA Plane):	**North: 134395.320**	**East: 566772.806**	**Elevation (m): 203.243**
Drill Date: 11/31/1971	**Type: Cable Tool**	**Depth (ft): 144**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 02/09/04**	**D/W Reference: Stoller**	
Comments: This borehole was deepened in May 1973 from 100 to 140 ft.			

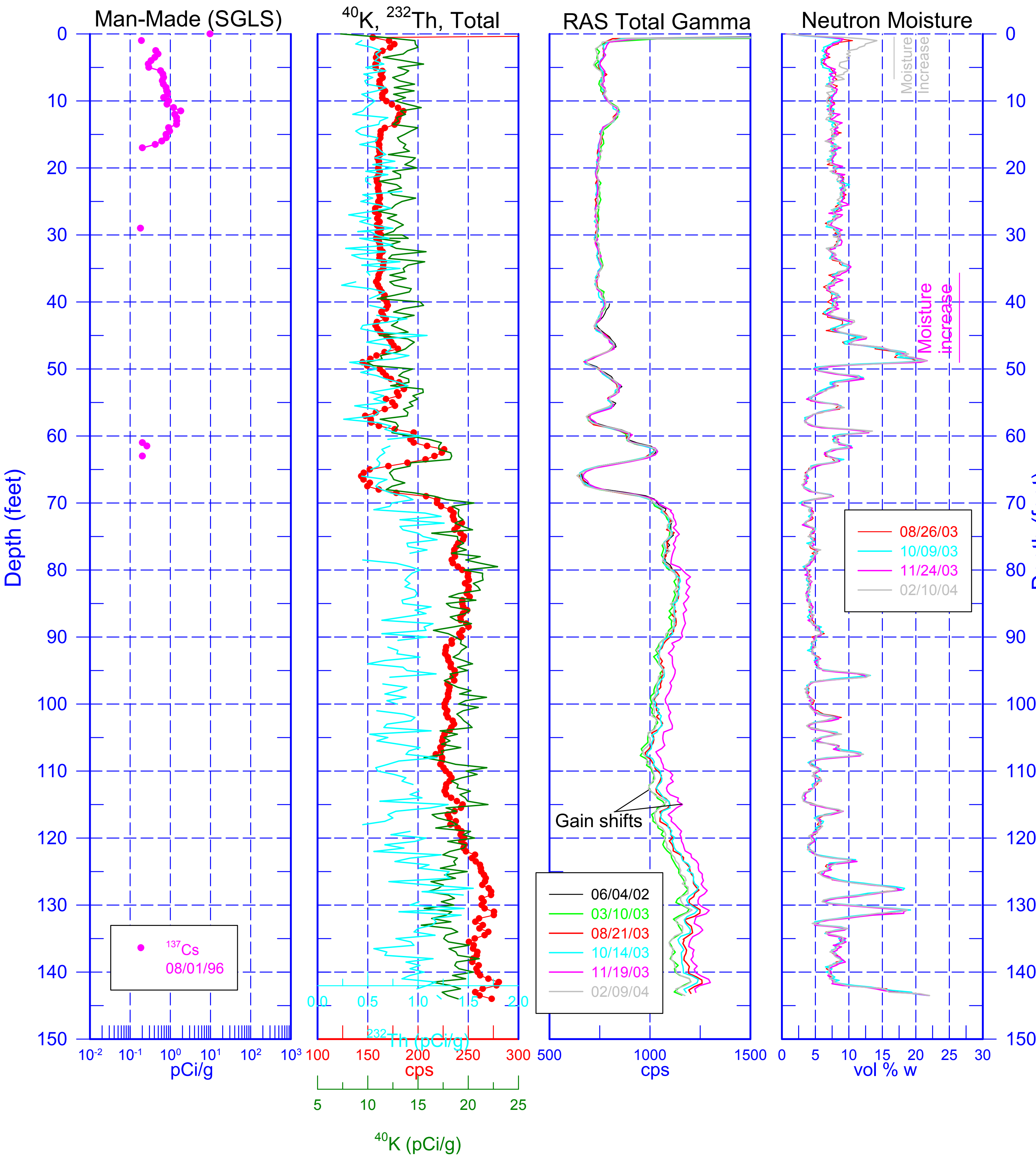
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	145	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
08/01/96	SGLS	G1A	NA	0-144	MACTEC-ERS	Baseline
06/04/02	RAS	Large	A	40-80	MACTEC-ERS	No Change
03/10/03	RAS	Large-New	B	0-144	Stoller	No Change
08/21/03	RAS	Large-New	C	0-144	Stoller	No Change (gain drift)
08/26/03	NMLS	Moisture	1	0-143.5	Stoller	Moisture Baseline
10/09/03	NMLS	Moisture	2	0-143.5	Stoller	No Change
10/14/03	RAS	Large-New	D	0-144	Stoller	No Change
11/19/03	RAS	Large-New	E	0-144	Stoller	No Change (gain drift)
11/24/03	NMLS	Moisture	3	0-143.5	Stoller	Poss. Incr. 36-49 ft.
02/09/04	RAS	Large-New	F	0-144	Stoller	No Change
02/10/04	NMLS	Moisture	4	0-143.5	Stoller	Poss. Incr. 0-7 ft.

Tank S-112
40-12-06



Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-12-07 (299-W23-208) (A8044)

Borehole Information

Site: S Farm, Tank S-112			
Coordinates (HAN Plant):	**North: 35885**	**West: 75901**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: 134399.018**	**East: 566759.392**	**Elevation (m): 203.109**
Drill Date: 3/31/1976	**Type: Cable Tool**	**Depth (ft): 98.5**	**Depth Datum: TOC**
Depth/Water (ft): 95.6	**D/W Date: 2/6/04**	**D/W Reference: Stoller**	
Comments: The top 20 ft of this borehole was grouted. The bottom of the borehole was filled with grout.			

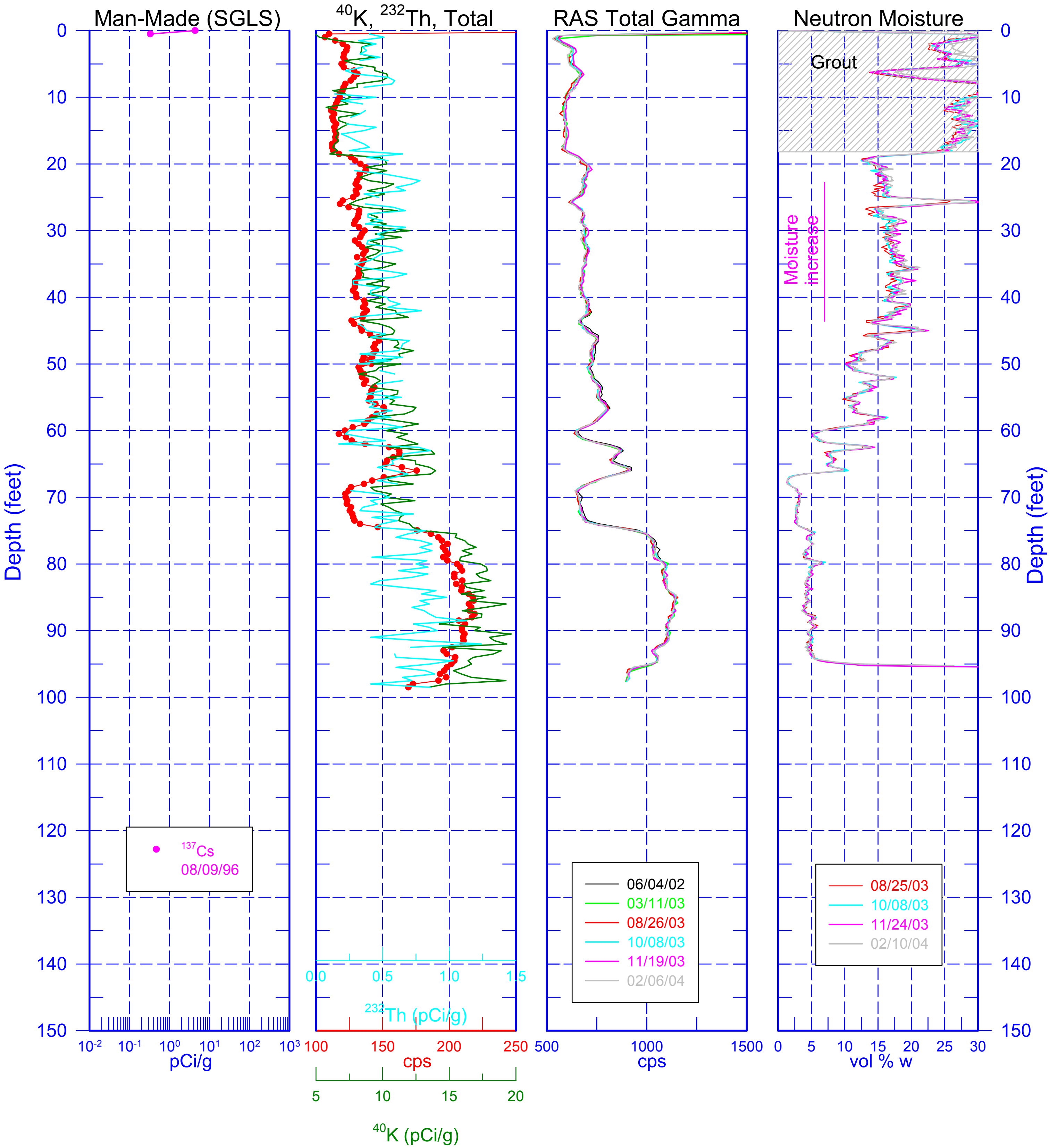
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
8/9/1996	SGLS	G2A	NA	0-98.5	MACTEC-ERS	Baseline
6/4/2002	RAS	Large	A	40-80	MACTEC-ERS	No Change
03/11/03	RAS	Large-New	B	0-98	Stoller	No Change
08/25/03	NMLS	Moisture	1	0-95.75	Stoller	Moisture Baseline
08/26/03	RAS	Large-New	C	0-98	Stoller	No Change
10/08/03	NMLS	Moisture	2	0-97.5	Stoller	No Change
10/08/03	RAS	Large-New	D	0-98	Stoller	No Change
11/19/03	RAS	Large-New	E	0-98	Stoller	No Change
11/24/03	NMLS	Moisture	3	0-95.5	Stoller	Poss. Incr. 22-43 ft.
02/06/04	RAS	Large-New	F	0-98	Stoller	No Change
02/10/04	NMLS	Moisture	4	0-95.25	Stoller	No Change

Tank S-112
40-12-07



Borehole Number (Alias): 40-12-09 (299-W23-176) (A8012)

Borehole Information

Site: S Farm, Tank S-112			
Coordinates (HAN Plant):	North: 35924	West: 75915	Elevation (ft): 663.21
Coordinates (WA Plane):	North: 134410.485	East: 566758.812	Elevation (m): 203.177
Drill Date: 11/30/1971	Type: Cable Tool	Depth (ft): 98.75	Depth Datum: TOC
Depth/Water (ft): Dry	D/W Date: 2/6/04	D/W Reference: Stoller	
Comments: None.			

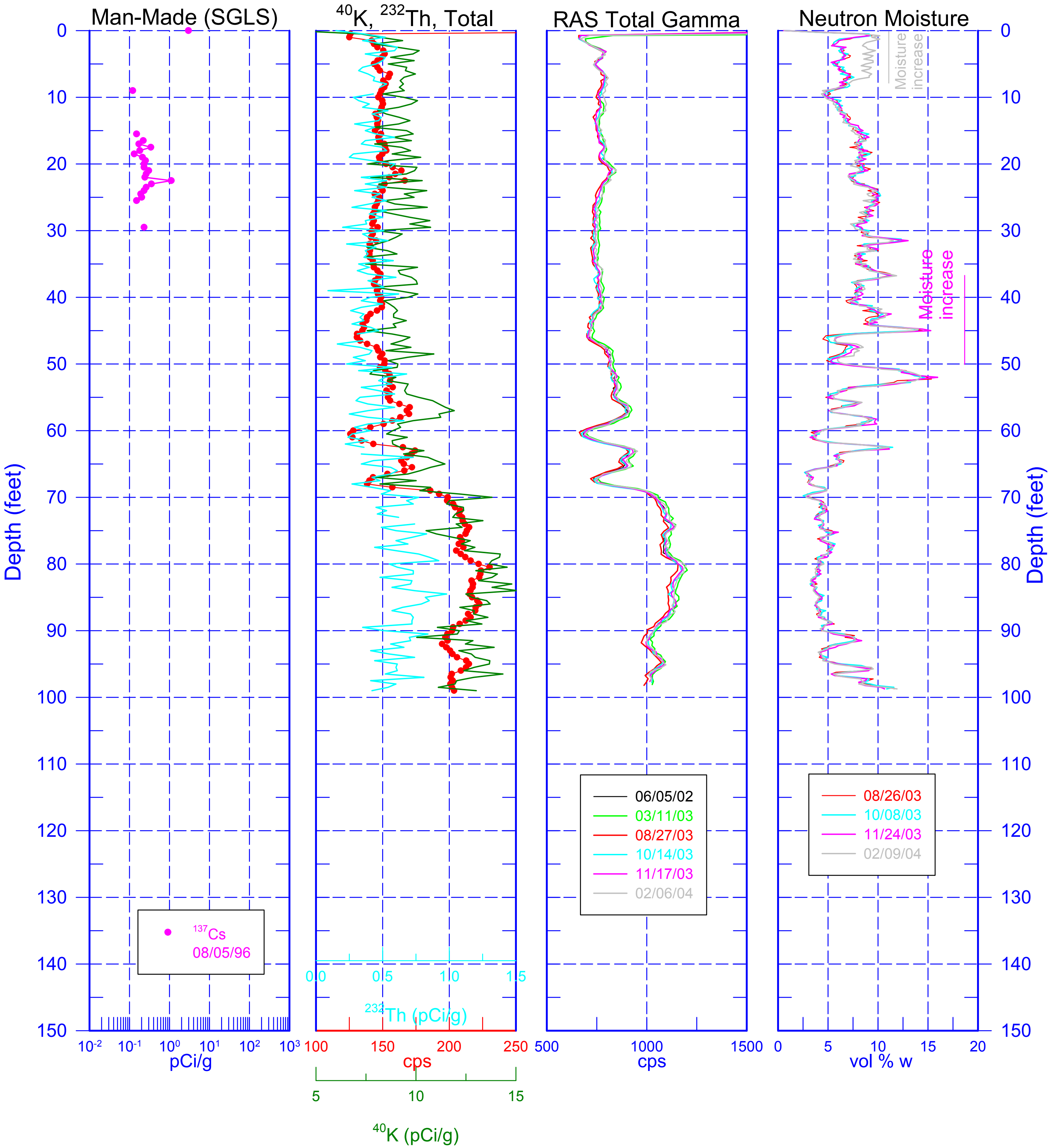
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
08/05/96	SGLS	G2A	NA	0-99	MACTEC-ERS	Baseline
06/05/02	RAS	Large	A	40-80	MACTEC-ERS	No Change
03/11/03	RAS	Large-New	B	0-99	Stoller	No Change
08/26/03	NMLS	Moisture	1	0-98.75	Stoller	Moisture Baseline
08/27/03	RAS	Large-New	C	0-99	Stoller	No Change
10/08/03	NMLS	Moisture	1	0-98.75	Stoller	No Change
10/14/03	RAS	Large-New	D	0-98	Stoller	No Change
11/17/03	RAS	Large-New	E	0-98	Stoller	No Change
11/24/03	NMLS	Moisture	3	0-98.75	Stoller	Poss. Incr. 36-50 ft.
02/06/04	RAS	Large-New	F	0-98	Stoller	No Change
02/09/04	NMLS	Moisture	4	0-98.75	Stoller	Poss. Incr. 0-8 ft.

Tank S-112
40-12-09



Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-09-06 (299-W23-166) (A8002)

Borehole Information

Site: S Farm, Tank S-109			
Coordinates (HAN Plant):	**North: 35977**	**West: 75877**	**Elevation (ft): 663.55**
Coordinates (WA Plane):	**North: 134426.712**	**East: 566770.365**	**Elevation (m): 203.285**
Drill Date: 10/31/1971	**Type: Cable Tool**	**Depth (ft): 98**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 2/5/05**	**D/W Reference: Stoller**	
Comments: None.			

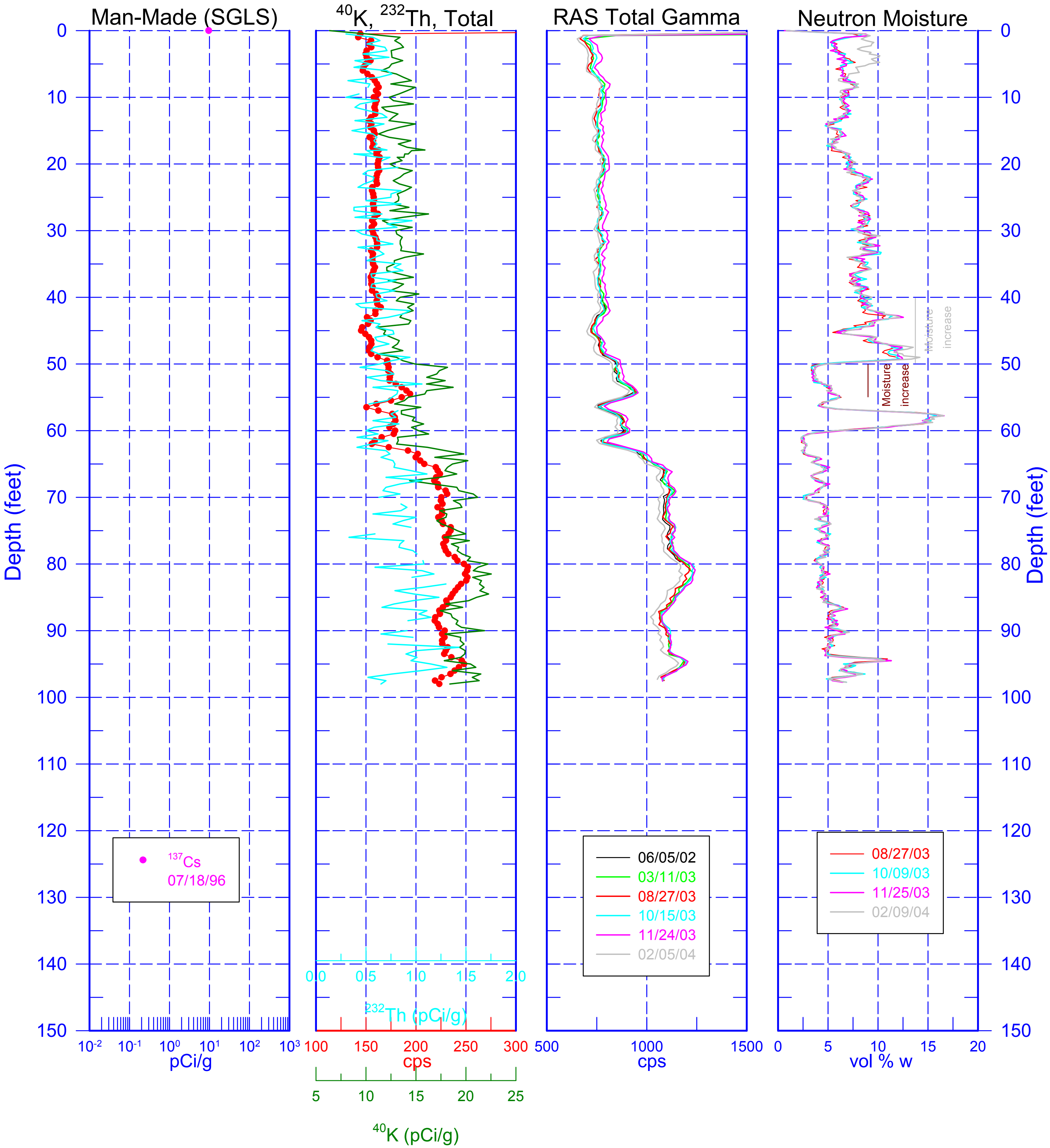
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
07/18/96	SGLS	G1A	NA	0-98	MACTEC-ERS	Baseline
06/05/02	RAS	Large	A	40-80	MACTEC-ERS	No Change
03/11/03	RAS	Large-New	B	0-98	Stoller	No Change
08/27/03	NMLS	Moisture	1	0-97.75	Stoller	Moisture Baseline
08/27/03	RAS	Large-New	C	0-98	Stoller	No Change
10/09/03	NMLS	Moisture	2	0-97.75	Stoller	No Change
10/15/03	RAS	Large-New	D	0-98	Stoller	No Change
11/24/03	RAS	Large-New	E	0-98	Stoller	No Change
11/25/03	NMLS	Moisture	3	0-97.75	Stoller	No Change
02/05/04	RAS	Large-New	F	0-98	Stoller	No Change
02/09/04	NMLS	Moisture	4	0-97.75	Stoller	Poss. incr. 40-50 ft

Tank S-109
40-09-06



Appendix F
Tank S-102 Retrieval Monitoring
Log Plots

Stoller
Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-02-08 (299-W23-189) (A8025)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36204**	**West: 75815**	**Elevation (ft): 663.80**
Coordinates (WA Plane):	**North: 134495.937**	**East: 566789.226**	**Elevation (m): 203.371**
Drill Date: 2/28/1974	**Type: Cable Tool**	**Depth (ft): 100**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 4/6/04**	**D/W Reference: Stoller**	
Comments: None.			

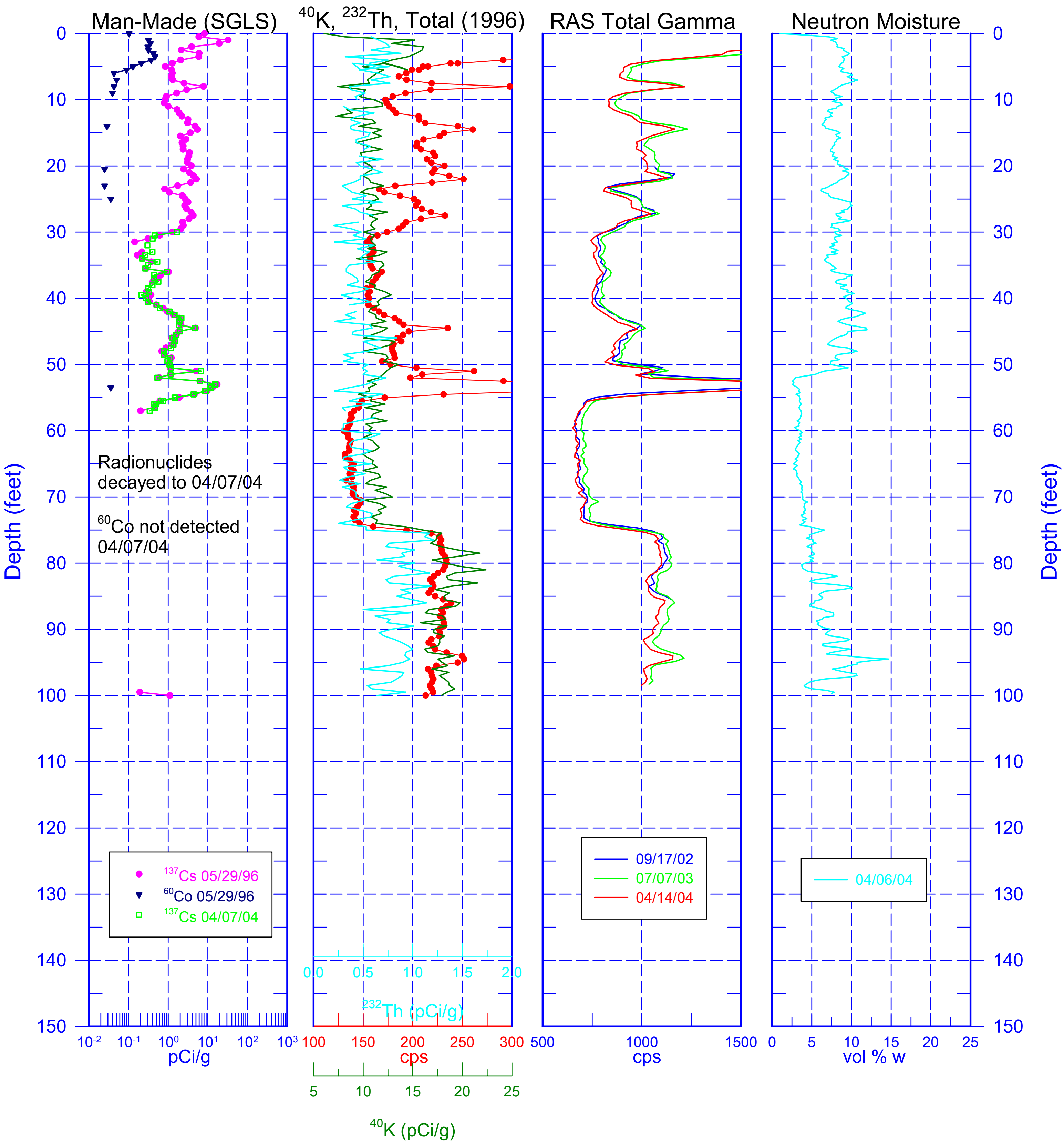
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/29/1996	SGLS	G1A	NA	0-100	MACTEC-ERS	Baseline
9/17/2002	RAS	Large	A	20-85	Stoller	No Change
7/7/2003	RAS	Large-New	B	0-99	Stoller	No Change
4/6/2004	NMLS	Moisture	1	0-100	Stoller	Baseline
4/7/2004	SGLS	G2A	NA	30-60	Stoller	No Change
4/14/2004	RAS	Large2	C	0-99	Stoller	No Change

Tank S-102
40-02-08



Borehole Number (Alias): 40-03-03 (299-W23-212) (A8046)

Borehole Information

Site: S Farm, Tank S-103			
Coordinates (HAN Plant):	**North: 36228**	**West: 75823**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: 134503.646**	**East: 566786.677**	**Elevation (m): 203.314**
Drill Date: 6/30/1978	**Type: Cable Tool**	**Depth (ft): 123.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 4/8/04**	**D/W Reference: Stoller**	
Comments: This borehole is grout from 0-18 ft and the bottom of the borehole was filled with grout.			

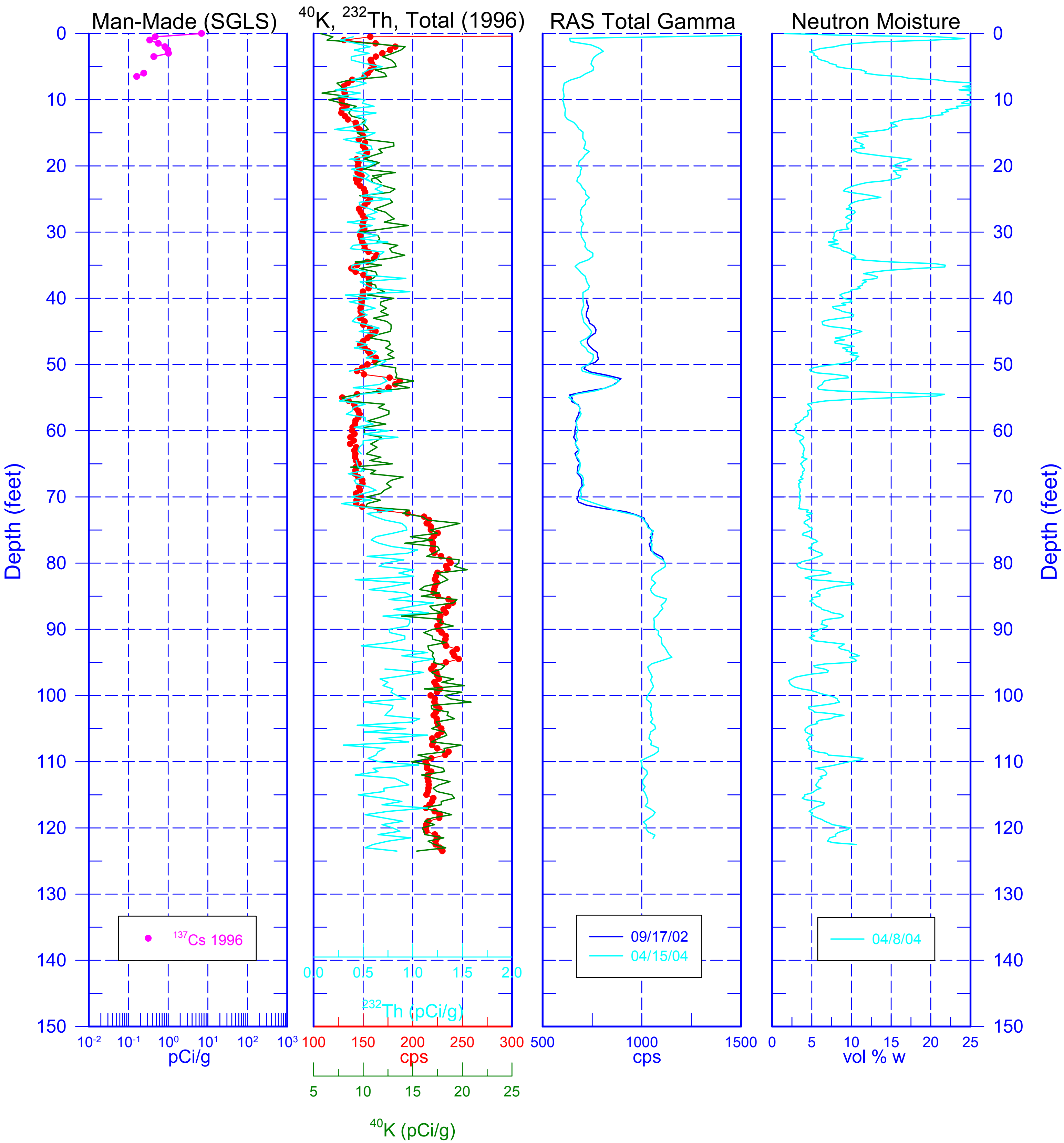
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	125	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
05/31/96	SGLS	G1A	NA	0-123.5	MACTEC-ERS	Baseline
09/16/02	RAS	Large	A	40-80	Stoller	No Change
04/08/04	NMLS	Moisture	1	0-122.5	Stoller	Moisture Baseline
04/15/04	RAS	Large2	B	0-122	Stoller	No Change
12/22/04	NMLS	Moisture	2	0-122.5	Stoller	No change

Tank S-102
40-03-03



Stoller
Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-02-01 (299-W23-148) (A7984)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36266**	**West: 75744**	**Elevation (ft): 664.19**
Coordinates (WA Plane):	**North: 134514.945**	**East: 566810.688**	**Elevation (m): 203.481**
Drill Date: 9/30/1971	**Type: Cable Tool**	**Depth (ft): 130**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 6/18/03**	**D/W Reference: Stoller**	
Comments: This borehole was deepened from 100 ft to 130 ft in 1973.			

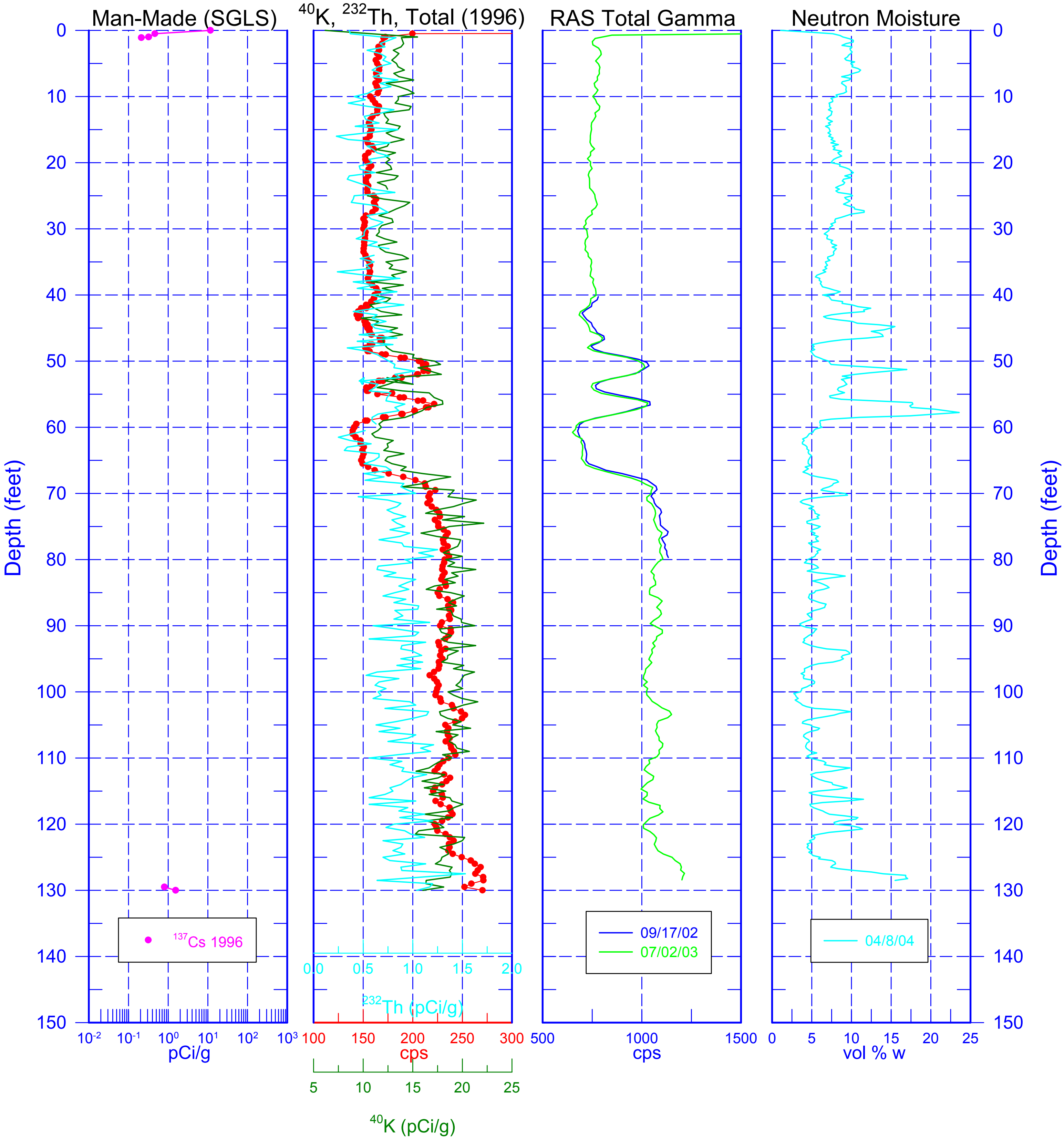
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	130	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
05/21/96	SGLS	G1A	NA	0-130	MACTEC-ERS	Baseline
09/17/02	RAS	Large	A	40-80	Stoller	No Change
07/02/03	RAS	Large-New	B	0-129	Stoller	No Change
04/08/04	NMLS	NA	1	0-129	Stoller	Baseline

Tank S-102
40-02-01



Borehole Number (Alias): 40-02-03 (299-W23-188) (Unk)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36249**	**West: 75726**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: Unk**	**East: Unk**	**Elevation (m): Unk**
Drill Date: 2/27/1974	**Type: Cable Tool**	**Depth (ft): 98.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 6/18/03**	**D/W Reference: Stoller**	
Comments: None.			

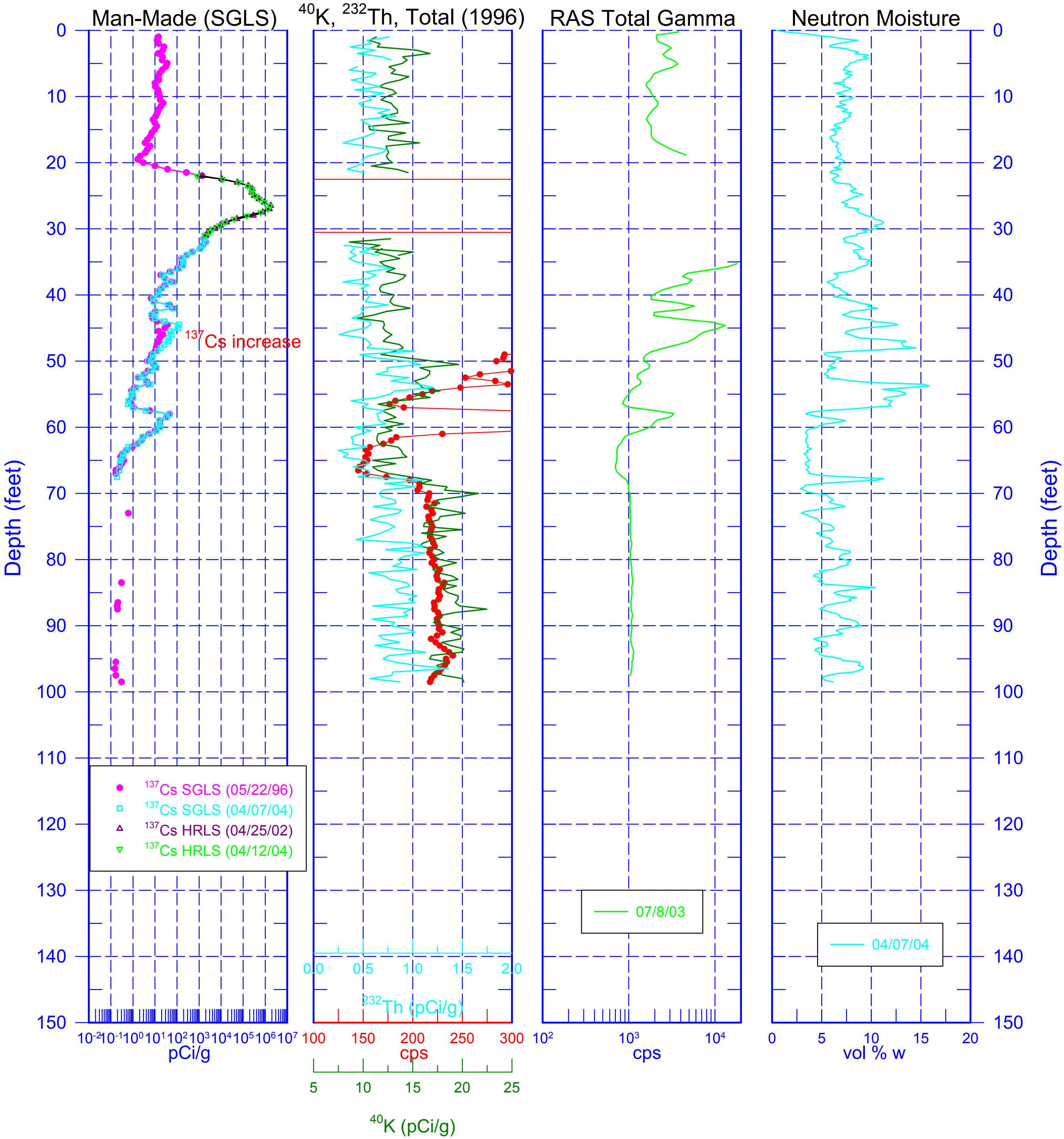
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/22/1996	SGLS	G1A	NA	1-98.5	MACTEC-ERS	Baseline
9/27/1999	HRLS	G1C	NA	20-35	MACTEC-ERS	Baseline-Highrate
4/25/2002	HRLS	G1C	NA	22-31	MACTEC-ERS	Highrate-Repeat
7/8/2003	RAS	Large-New	A	0-19&35-98	Stoller	Cs-137 inc. 44-47 ft.
7/8/2003	RAS	Small	A	15-23&29-40	Stoller	No Change
4/7/2004	SGLS	G2A	NA	31-70	Stoller	Cs inc. 44-47 ft. confirmed
4/7/2004	NMLS	NA	1	0-98.5	Stoller	Baseline
4/12/2004	HRLS	G1C	NA	22-31	Stoller	Tool efficiency change?

Tank S-102
40-02-03



Stoller
Hanford Office

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-02-11 (299-W23-182) (A8018)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36271**	**West: 75786**	**Elevation (ft): 665.24**
Coordinates (WA Plane):	**North: 134516.321**	**East: 566797.76**	**Elevation (m): 203.798**
Drill Date: 3/31/1974	**Type: Cable Tool**	**Depth (ft): 100.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 3/25/04**	**D/W Reference: Stoller**	
Comments: None.			

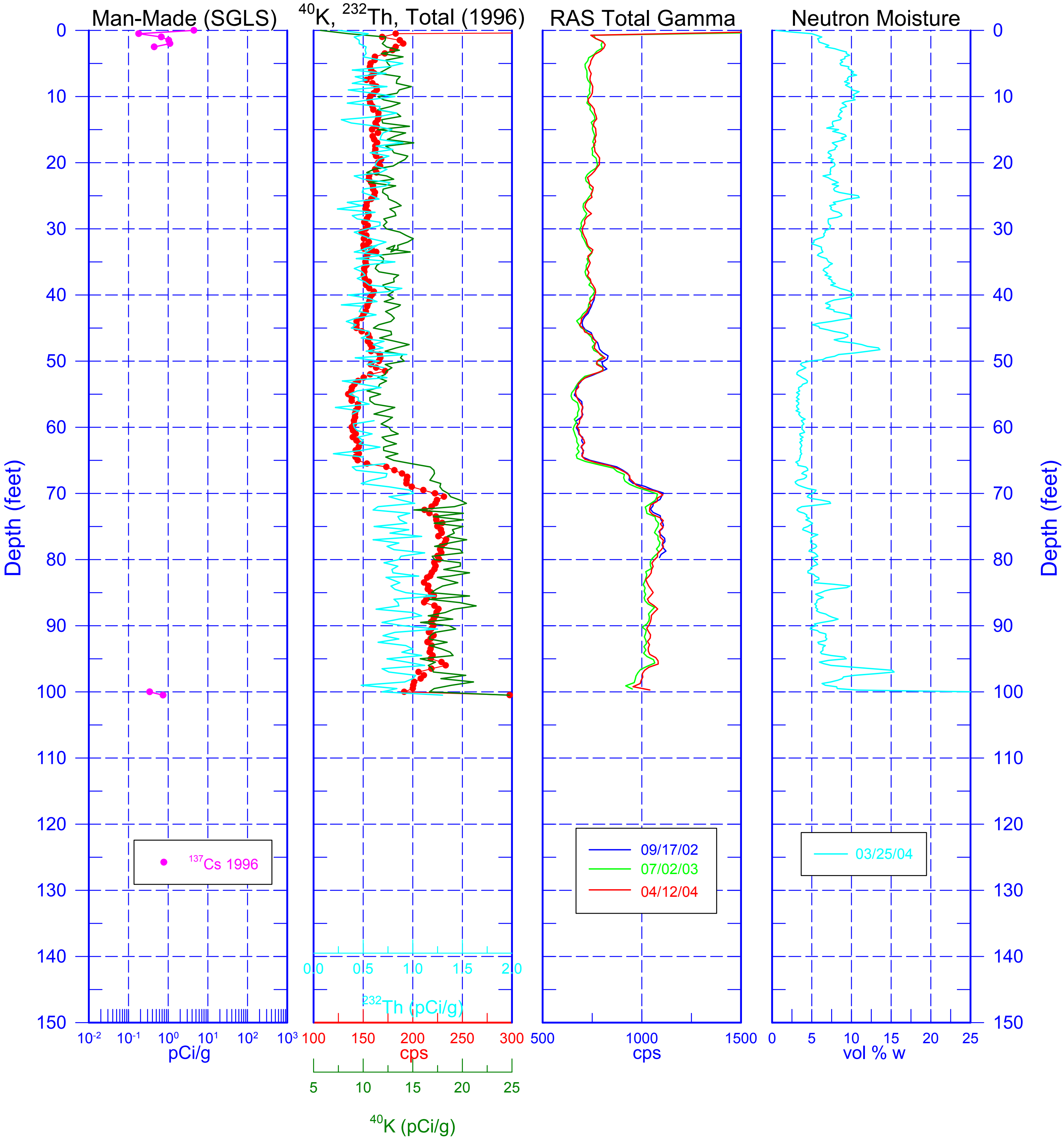
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/20/1996	SGLS	G1A	NA	0-100.5	MACTEC-ERS	Baseline
9/19/2002	RAS	Large	A	40-80	Stoller	No Change
7/2/2003	RAS	Large-New	B	0-100	Stoller	No Change
3/25/2004	NMLS	N/A	1	0-100	Stoller	Baseline
4/12/2004	RAS	Large2	C	0-100	Stoller	No Change

Tank S-102
40-02-11



Borehole Number (Alias): 40-02-10 (299-W23-150) (A7986)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36242**	**West: 75810**	**Elevation (ft): 663.68**
Coordinates (WA Plane):	**North: 134507.539**	**East: 566790.522**	**Elevation (m): 203.327**
Drill Date: 10/31/1971	**Type: Cable Tool**	**Depth (ft): 100**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 4/6/04**	**D/W Reference: Stoller**	
Comments: None.			

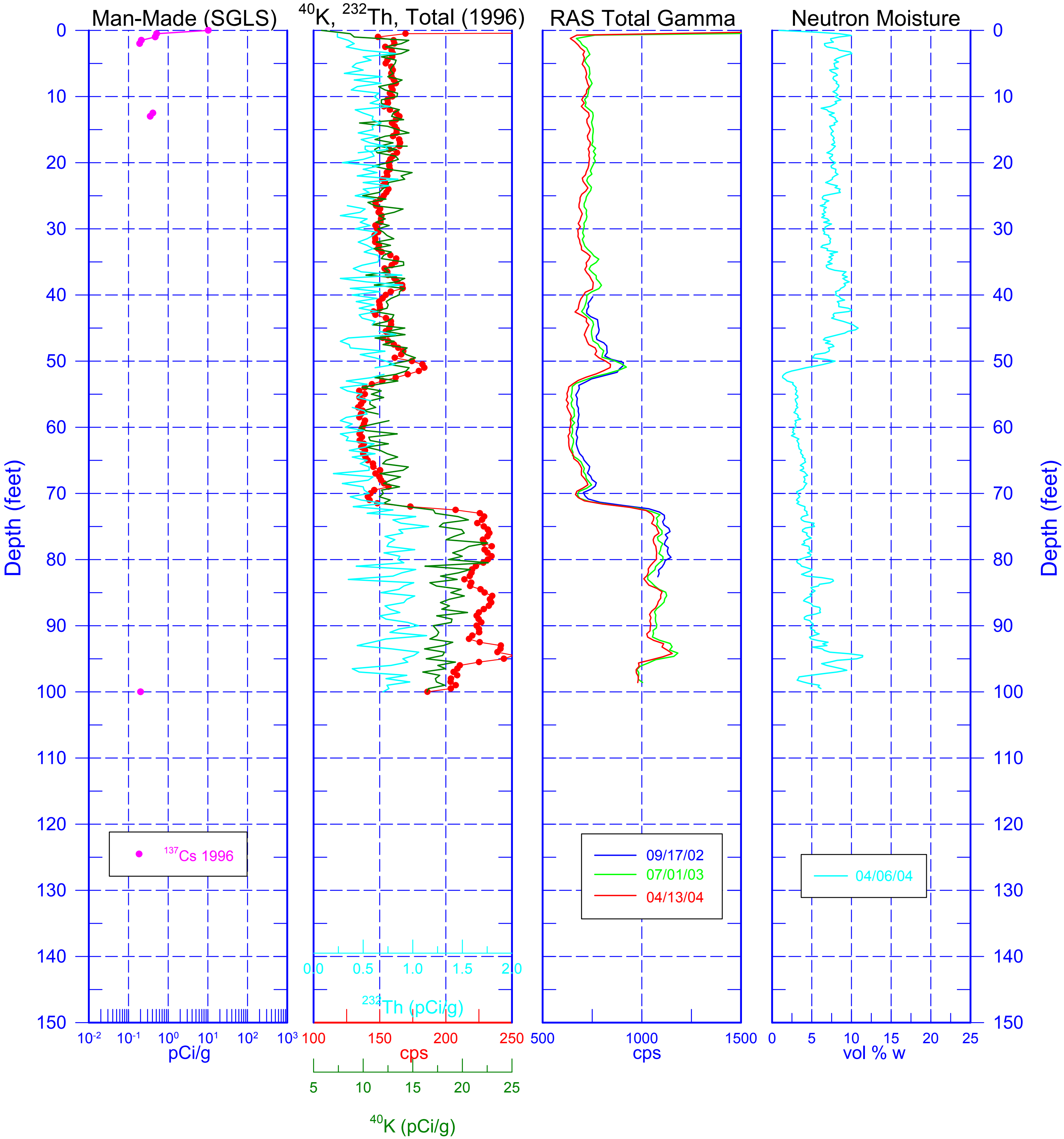
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/30/1996	SGLS	G1A	NA	0-100	MACTEC-ERS	Baseline
9/17/2002	RAS	Large	A	40-80	Stoller	No Change
7/1/2003	RAS	Large-New	B	0-100	Stoller	No Change
4/6/2004	NMLS	Moisture	1	0-95.5	Stoller	Baseline
4/13/2004	RAS	Large2	C	0-99	Stoller	No Change

Tank S-102
40-02-10



Borehole Number (Alias): 40-02-07 (299-W23-149) (A7985)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36183**	**West: 75783**	**Elevation (ft): 663.65**
Coordinates (WA Plane):	**North: 134489.545**	**East: 566798.674**	**Elevation (m): 203.315**
Drill Date: 9/30/1971	**Type: Cable Tool**	**Depth (ft): 95.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 3/31/04**	**D/W Reference: Stoller**	
Comments: None.			

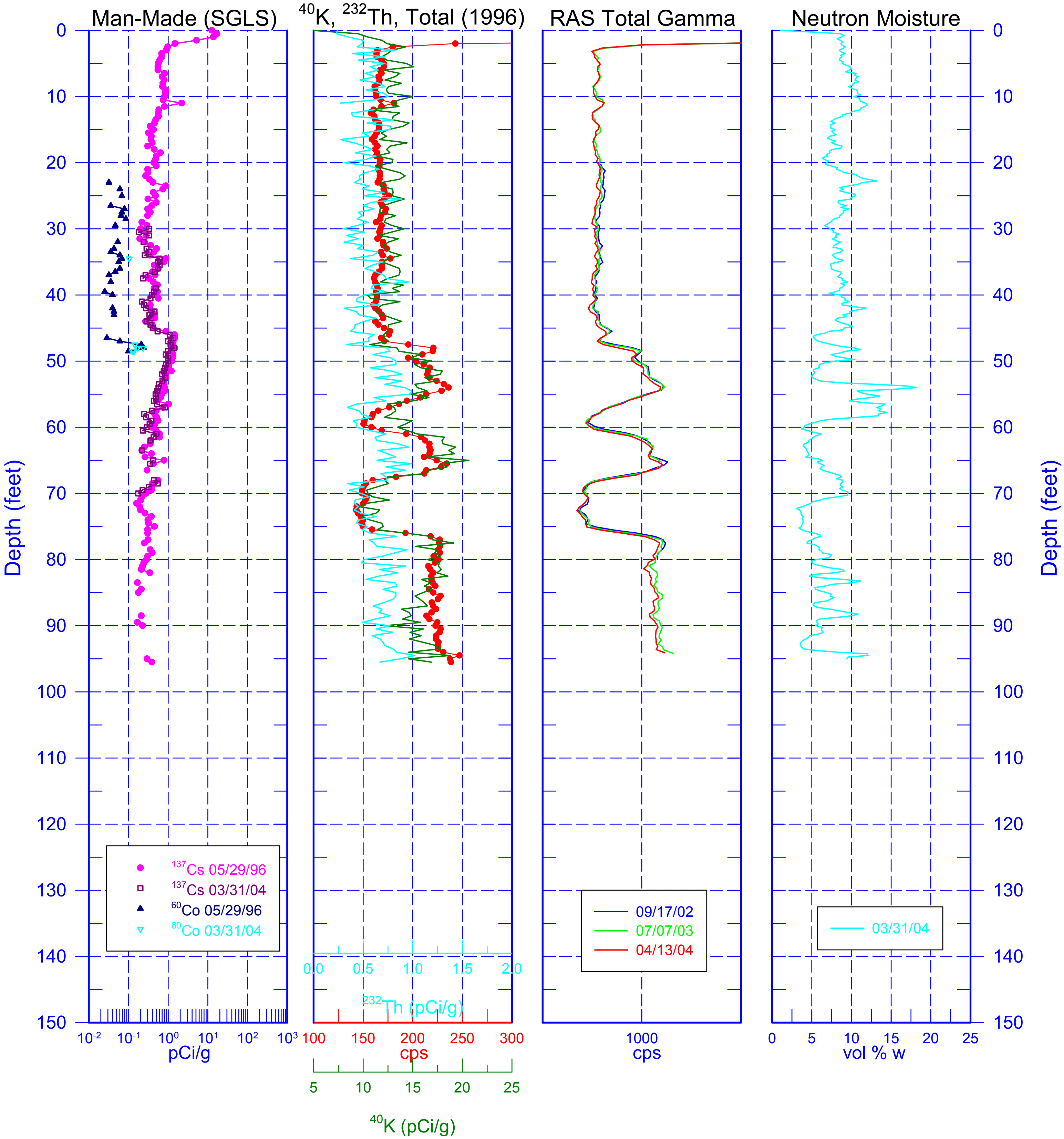
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/29/1996	SGLS	G1A	NA	0-95.5	MACTEC-ERS	Baseline
9/17/2002	RAS	Large	A	20-80	Stoller	No Change
7/7/2003	RAS	Large-New	B	0-95	Stoller	No Change
3/31/2004	SGLS	G2A	Repeat	30-70	Stoller	No change
3/31/2004	NMLS	N/A	1	0-95	Stoller	Baseline
4/13/2004	RAS	Large2	C	0-95	Stoller	No Change

Tank S-102
40-02-07



Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-02-05 (299-W23-181) (A8017)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36183**	**West: 75753**	**Elevation (ft): 664.10**
Coordinates (WA Plane):	**North: 134489.49**	**East: 566807.763**	**Elevation (m): 203.459**
Drill Date: 3/31/1974	**Type: Cable Tool**	**Depth (ft): 98**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 6/18/03**	**D/W Reference: Stoller**	
Comments: None.			

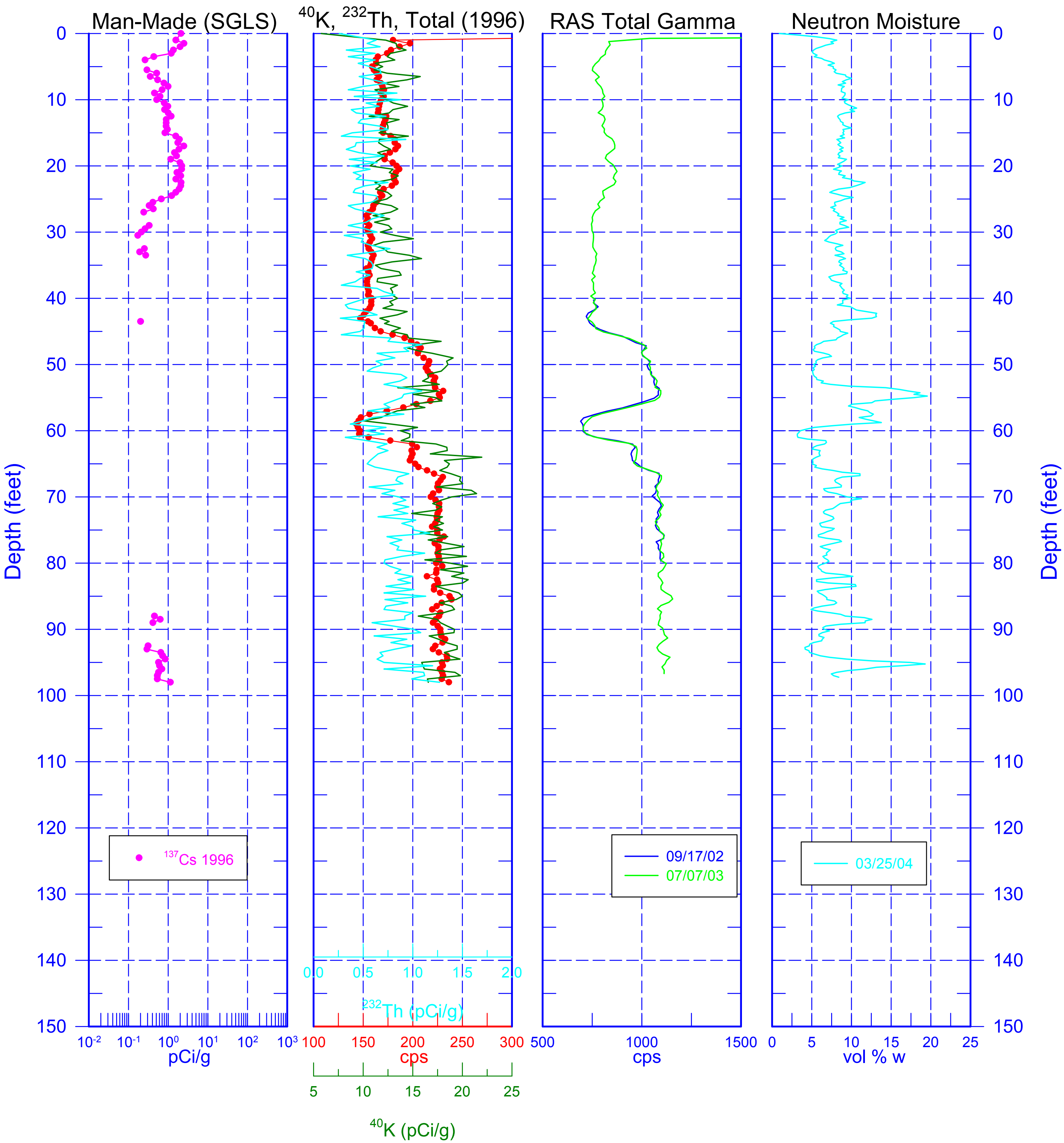
Casing Information

Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	100	6	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/28/1996	SGLS	G1A	NA	0-98	MACTEC-ERS	Baseline
9/17/2002	RAS	Large	A	40-80	Stoller	No Change
7/7/2003	RAS	Large-New	B	0-97	Stoller	No Change
3/25/2004	NMLS	Moisture	1	0-97.25	Stoller	Moisture-Baseline

Tank S-102
40-02-05



Stoller Grand Junction Office established 1959

Hanford Single Shell Tank Farms
Borehole Geophysics Summary Sheet

Borehole Number (Alias): 40-02-04 (299-W23-52) (A7888)

Borehole Information

Site: S Farm, Tank S-102			
Coordinates (HAN Plant):	**North: 36186**	**West: 75722**	**Elevation (ft): 663.00**
Coordinates (WA Plane):	**North: 134509.725**	**East: 566815.338**	**Elevation (m): 204.058**
Drill Date: 3/13/1952	**Type: Cable Tool**	**Depth (ft): 144.5**	**Depth Datum: TOC**
Depth/Water (ft): Dry	**D/W Date: 7/9/03**	**D/W Reference: Stoller**	
Comments: The casing is perforated from 40 to 100 ft.			

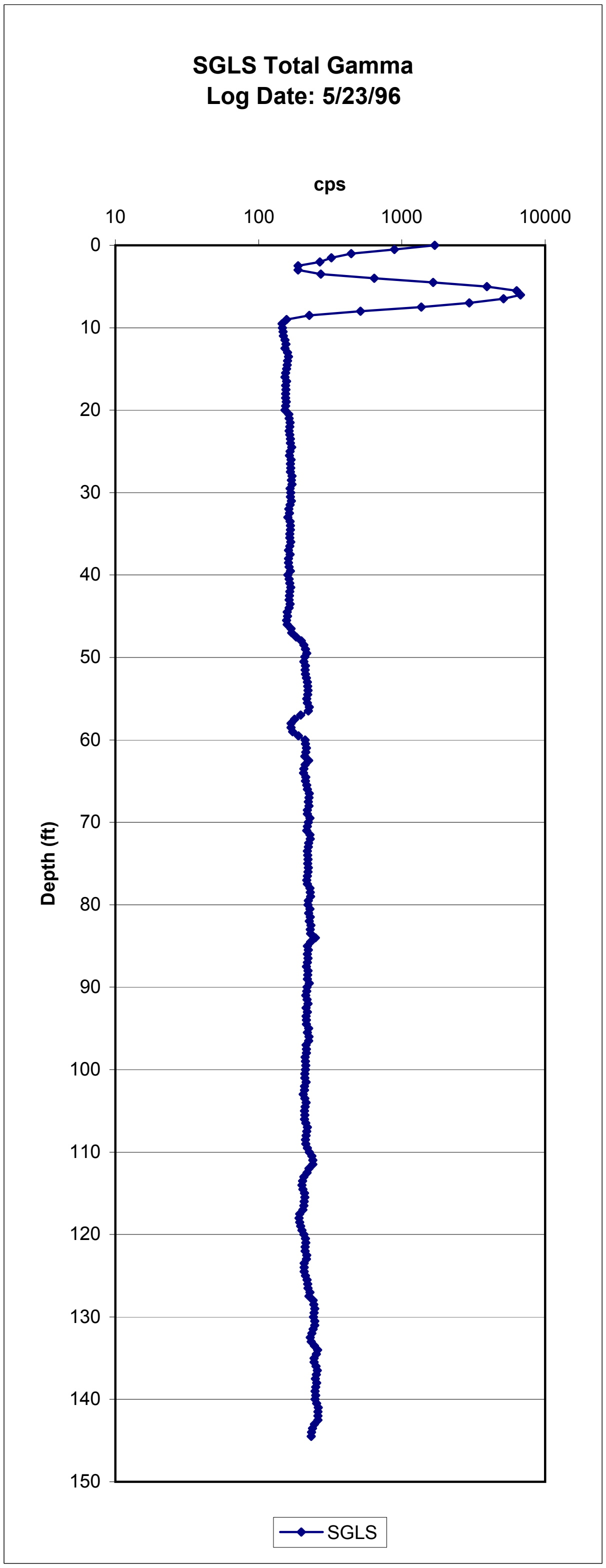
Casing Information

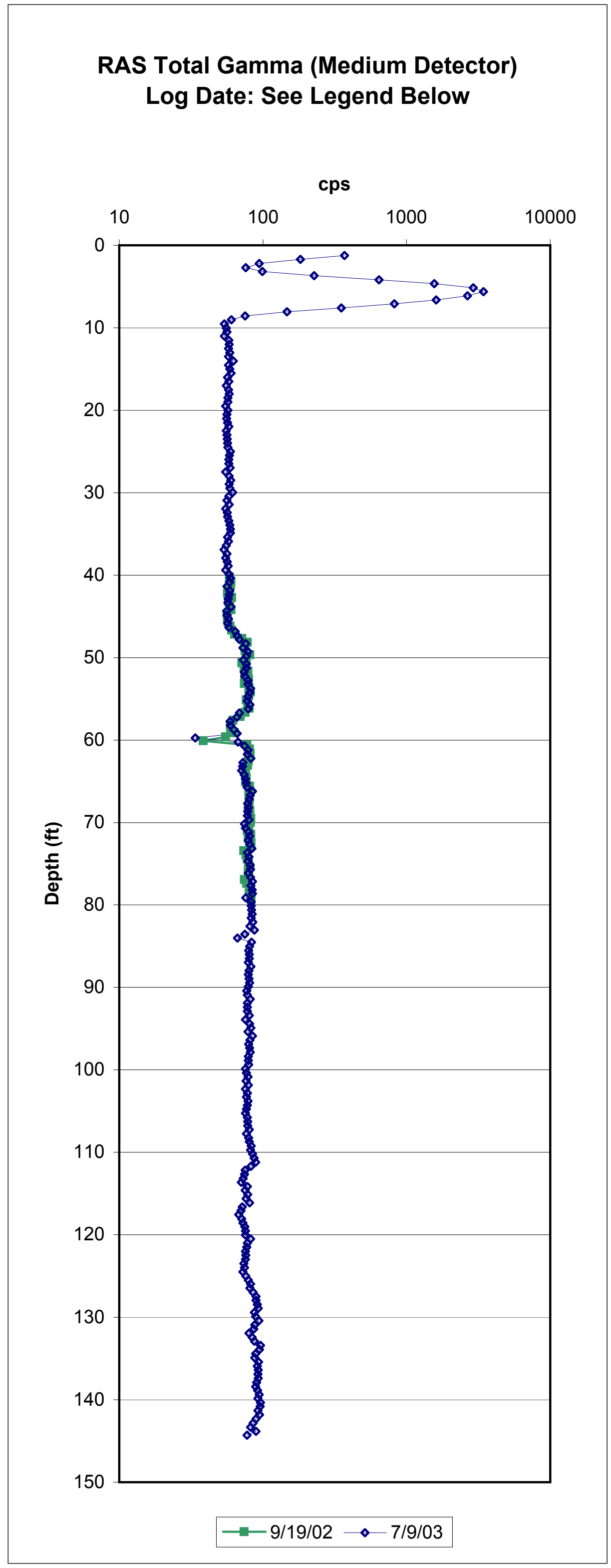
Type	Top(ft)	Bottom (ft)	ID (in)	Thick. (in)	Stickup (ft)	Reference
Steel	0	150	5	0.28	0	Stoller

Log Run Information

Log Date	System	Detector	Event	Log int. (ft)	Contractor	Comments
5/8/1963	Nat. Gamma	Unk	NA	0-145	PNL	On File at Sigma 5
5/23/1996	SGLS	G2A	NA	0-144.5	MACTEC-ERS	Baseline
9/19/2002	RAS	Medium	A	40-80	Stoller	No Change
7/9/2003	RAS	Medium	B	0-144	Stoller	No Change

Borehole 40-02-04





Appendix G
Tank C-105 Characterization Drilling
Log Plots for Borehole C4297

Stoller Hanford Office

DOE-EM/GJ622-2004

C4297
Log Data Report

Borehole Information:

Borehole: C4297			Site: 241-C-105		
Coordinates (Hanford Plant)		GWL (ft)[1]: Dry		GWL Date: 03/23/04	
North	West	Drill Date	Ground Level Elevation	Total Depth (ft)	Type
42819.84 ft	48359.79	03/04	Not Available	196.5	Percussion

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0.7	10 3/4	9 3/4	1/2	0	152.09
Threaded Steel	3.7	8 5/8	7 5/8	1/2	0	195.58

Borehole Notes:

Casing, drilling, and groundwater information were provided by the driller. The casing thickness of 0.5 in. was confirmed by e-mail from David Myers of CH2M HILL. The coordinates were also provided by CH2M HILL. Logging data acquisition is referenced to the ground surface.

Logging Equipment Information:

Logging System:	Gamma 1E		Type: SGLS (70%) SN: 34TP40587A
Calibration Date:	01/04	Calibration Reference:	GJO-2004-568-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 2A		Type: SGLS (35%)
Calibration Date:	03/04	Calibration Reference:	Not yet available
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 2F		Type: NMLS (SN: H380932510)
Calibration Date:	09/03	Calibration Reference:	GJO-2003-520-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	3	4	5 Repeat	6	7
Date	03/03/04	03/03/04	03/03/04	03/19/04	03/19/04
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	149.43	149.0	50.0	194.62	194.0

Log Run	3	4	5 Repeat	6	7
Finish Depth (ft)	149.93	0.0	35.0	194.62	145.0
Count Time (sec)	100	100	100	200	200
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	None	1	1	None	1
ft/min	N/A[2]	N/A	N/A	N/A	N/A
Pre-Verification	AE098CAB	AE098CAB	AE098CAB	BA317CAB	BA317CAB
Start File	AE098000	AE098001	AE098151	BA317000	BA317001
Finish File	AE098000	AE098150	AE098166	BA317000	BA317050
Post-Verification	AE098CAA	AE098CAA	AE098CAA	BA317CAA	BA317CAA
Depth Return Error (in.)	N/A	-1	0	N/A	N/A
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	Fine-gain adjustment after: BA317003, -010, -022.

Log Run	8 Repeat				
Date	03/19/04				
Logging Engineer	Spatz				
Start Depth (ft)	160.0				
Finish Depth (ft)	155.0				
Count Time (sec)	200				
Live/Real	R				
Shield (Y/N)	N				
MSA Interval (ft)	1				
ft/min	N/A				
Pre-Verification	BA317CAB				
Start File	BA317051				
Finish File	BA317056				
Post-Verification	BA317CAA				
Depth Return Error (in.)	-0.25				
Comments	No fine-gain adjustment.				

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2 Repeat	9	10 Repeat	
Date	03/02/04	03/02/04	03/23/04	03/23/04	
Logging Engineer	Spatz	Spatz	Pearson	Pearson	
Start Depth (ft)	0.0	80.0	145.0	157.0	
Finish Depth (ft)	95.0	149.25	194.5	162.0	
Count Time (sec)	N/A	N/A	N/A	N/A	
Live/Real	N/A	N/A	N/A	N/A	
Shield (Y/N)	N/A	N/A	N/A	N/A	
Sample Interval (ft)	0.25	0.25	0.25	0.25	
ft/min	1.0	1.0	1.0	1.0	
Pre-Verification	BF161CAB	BF161CAB	BF162CAB	BF162CAB	
Start File	BF161000	BF161381	BF162000	BF162199	
Finish File	BF161380	BF161658	BF162198	BF162219	
Post-Verification	BF161CAA	BF161CAA	BF162CAA	BF162CAA	
Depth Return Error (in.)	N/A	+0.5	N/A	+.05	
Comments	No fine-gain adjustment.	Repeat 80-95 ft.	No fine-gain adjustment.	No fine-gain adjustment.	

Logging Operation Notes:

Spectral gamma and moisture logging were performed in this borehole during March 2004 on four separate days. SGLS G1E was used for logging runs 3, 4, and 5 and G2A for log runs 6, 7, and 8. Logging was conducted with a centralizer on the sonde. Logging measurements are referenced to ground surface. Repeat sections were collected in this borehole to evaluate system performance.

Analysis Notes:

Analyst:	Henwood	**Date:**	03/30/04	**Reference:**	GJO-HGLP 1.6.3, Rev. 0

Pre-run and post-run verifications for each logging system were performed for each day's log event. The acceptance criteria were met for all logging systems.

A casing correction for 0.5-in.-thick casing was applied for the steel casing to the total depth of the borehole. The 0.5-in. casing wall thickness is provided by CH2M HILL.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL worksheet templates identified as G2AFeb04.xls and G1EJan04.xls for the SGLSs, using efficiency functions and corrections for casing, water, and dead time as determined from annual calibrations. Dead time corrections are applied where dead times exceed 10.5 percent. Where SGLS dead time exceeds 40 percent, pulse pileup and peak spreading may occur in a spectrum that results in an underestimation of the concentration of man-made radionuclides. Dead time of 40 percent was exceeded in two depth intervals (13 and 14 ft). Because the interval of high dead time was thin, it was determined the HRLS could not be efficiently deployed to obtain data. No correction for water was necessary in this borehole.

NMLS log spectra were processed in batch mode using APTEC Supervisor to determine count rates. The volume fraction of water was not calculated because there is no valid calibration for a 10-in.-diameter borehole. However, increasing count rates are a reliable indicator of increasing moisture content.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (^{137}Cs, ^{154}Eu, and ^{60}Co) detected in the borehole, naturally occurring radionuclides (^{40}K, ^{238}U, ^{232}Th [KUT]), a combination of man-made, KUT, and moisture, and total gamma plotted with dead time. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. Repeat log sections are also included.

Results and Interpretations:

^{137}Cs, ^{154}Eu, and ^{60}Co were the man-made radionuclides detected in this borehole. ^{137}Cs was detected between the ground surface and 19 ft in depth at concentrations between 0.3 and 1,700 pCi/g. ^{137}Cs was also detected at a few locations near its MDL of approximately 0.2 pCi/g.

^{60}Co was detected at 12 and 15 ft and between 40 ft and 65 ft. The maximum concentration measured was approximately 1 pCi/g at 15 ft.

^{154}Eu was detected between 11 and 16 ft. The maximum concentration measured was approximately 400 pCi/g at 13 ft.

The profile of the ^{137}Cs, ^{154}Eu, and ^{60}Co between approximately 11 and 16 ft is suggestive of a point source of contamination such as a pipeline. A 3-in. inlet line #V103 that connects to the southwest quadrant of tank C-105 lies a few feet northeast from the location of the borehole at a depth of 13.63 ft below grade. It is hypothesized that the log data reflect contamination inside this pipeline.

Recognizable changes in the KUT and total gamma logs occurred in this borehole. At 39 ft, there is a 3-pCi/g increase in ^{40}K concentration and a decrease in relative moisture content. This increase in apparent ^{40}K concentration corresponds with the base of the backfill. An interval between 40 and 65 ft appears to reflect alternating layers and mixtures of sand and gravel that coincide with the ^{60}Co contamination. At 65 ft the ^{40}K concentrations increase about 5 pCi/g and a thin fine-grained sediment layer exists where relatively higher moisture content is shown. The downward movement of the ^{60}Co is apparently retarded by this layer. Another thin sediment layer is shown at 75 ft by an increase in ^{40}K, ^{232}Th, and moisture. Between 130 and 135 ft increases in KUT and moisture are exhibited.

Log runs 3, 4, and 5 conducted March 3, 2004 show indications of enhanced radon as reflected by a slightly elevated naturally occurring ^{238}U concentration between the ground surface and 150 ft in depth. Where the casing size change occurs at approximately 150 ft, the moisture shows an increase in count rate. This increase in count rate is the result of a change from 10-in. to 8-in. casing and probably not a significant difference in moisture content.

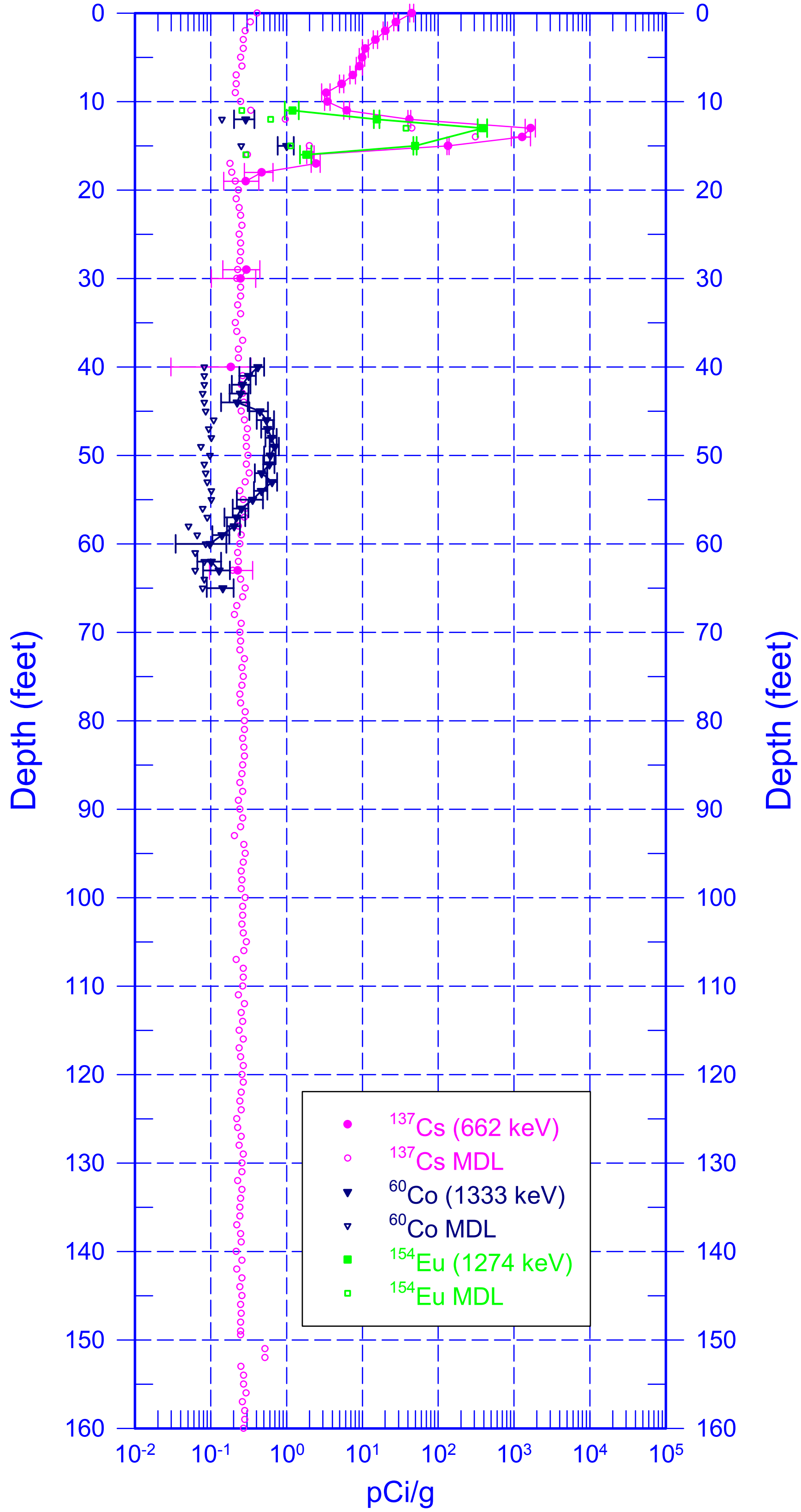
The repeat sections indicated good agreement of the man-made radionuclides, naturally occurring KUT, and moisture.

---

[1] GWL – groundwater level

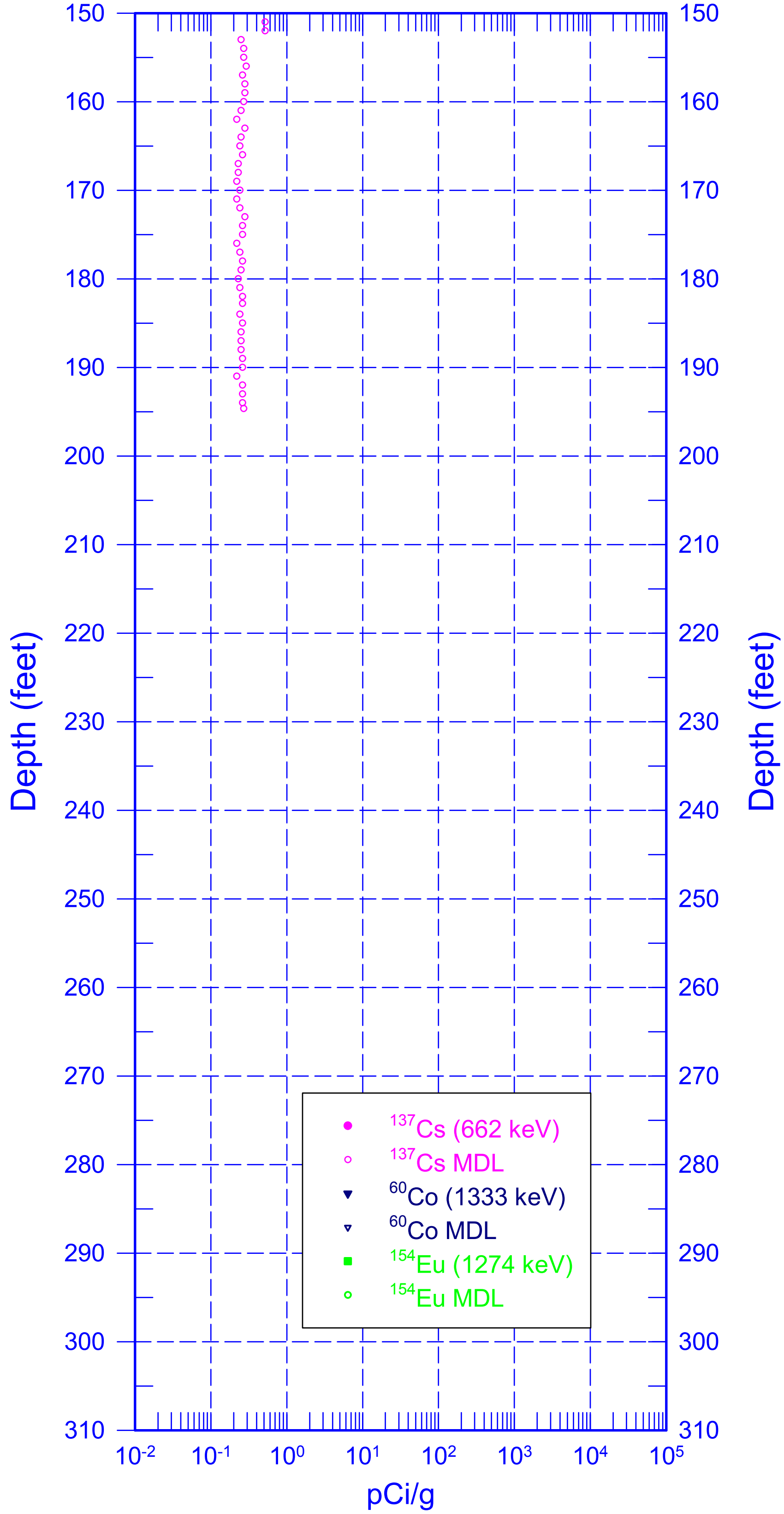
[2] N/A – not applicable

C4297
Man-Made Radionuclides



Zero Reference = Ground Surface   Depth scale: 1" = 20 ft   Last Log Date - 03/23/04

C4297
Man-Made Radionuclides

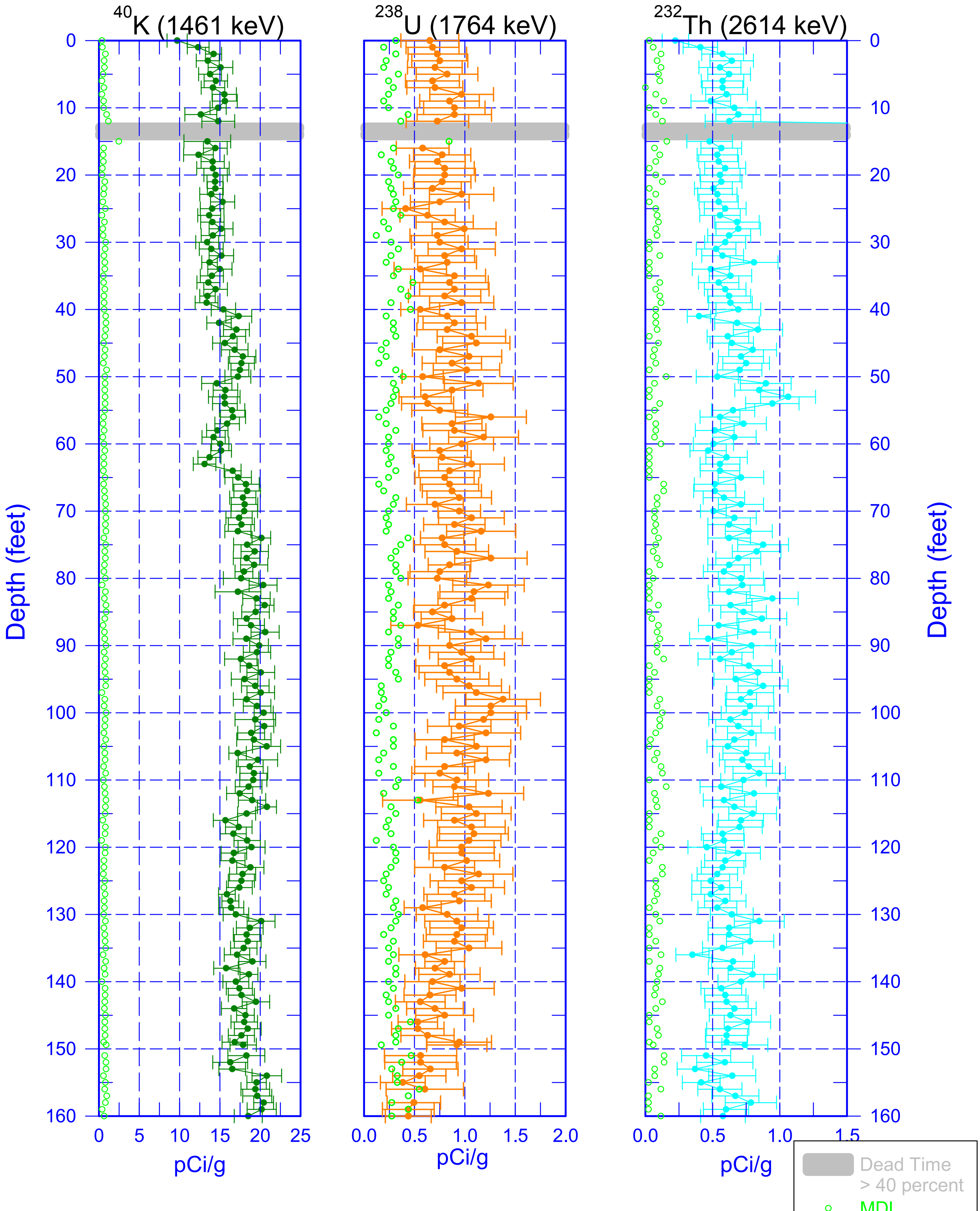


Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 03/23/04

C4297
Natural Gamma Logs

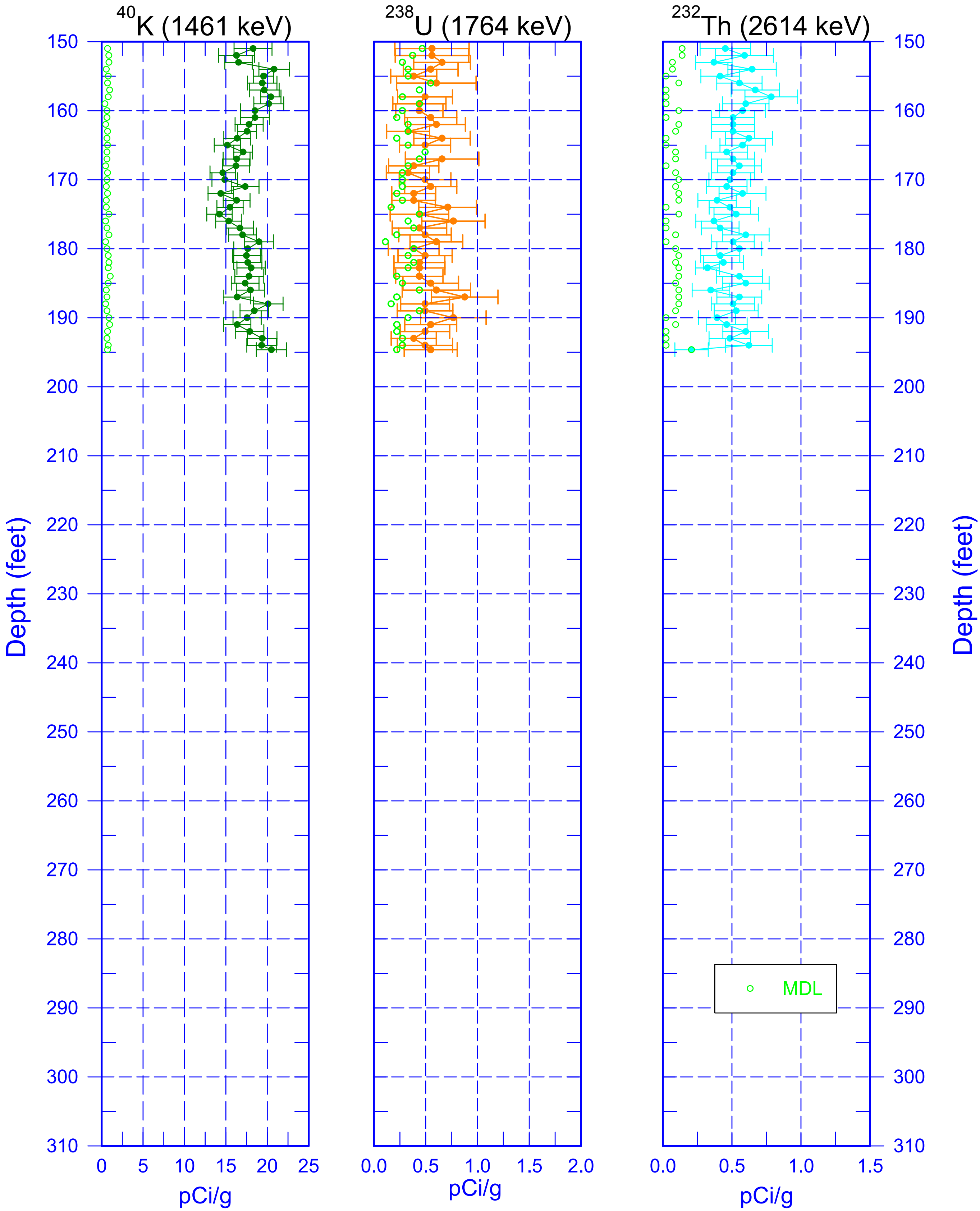


Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 03/23/04

C4297
Natural Gamma Logs

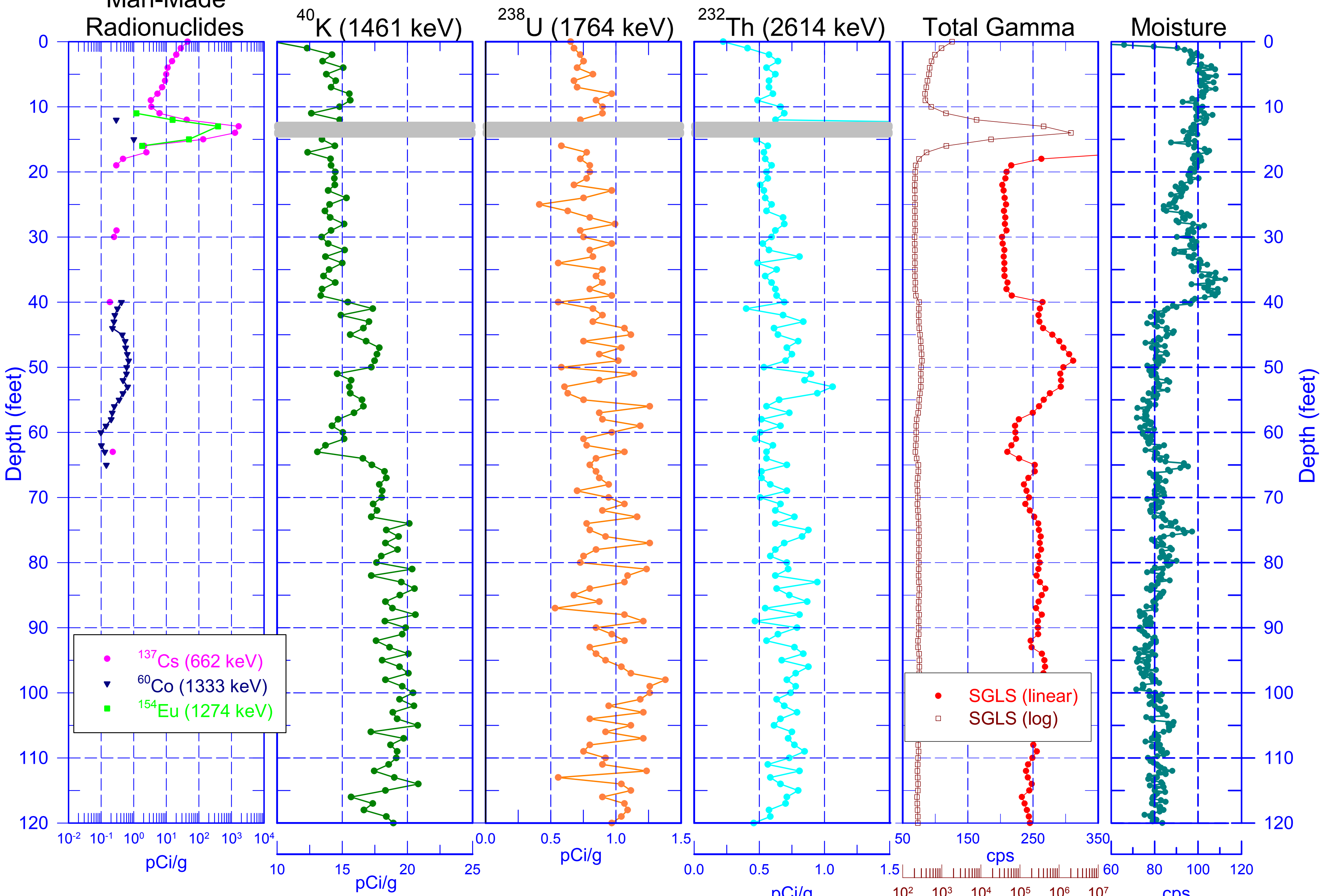


Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 03/23/04

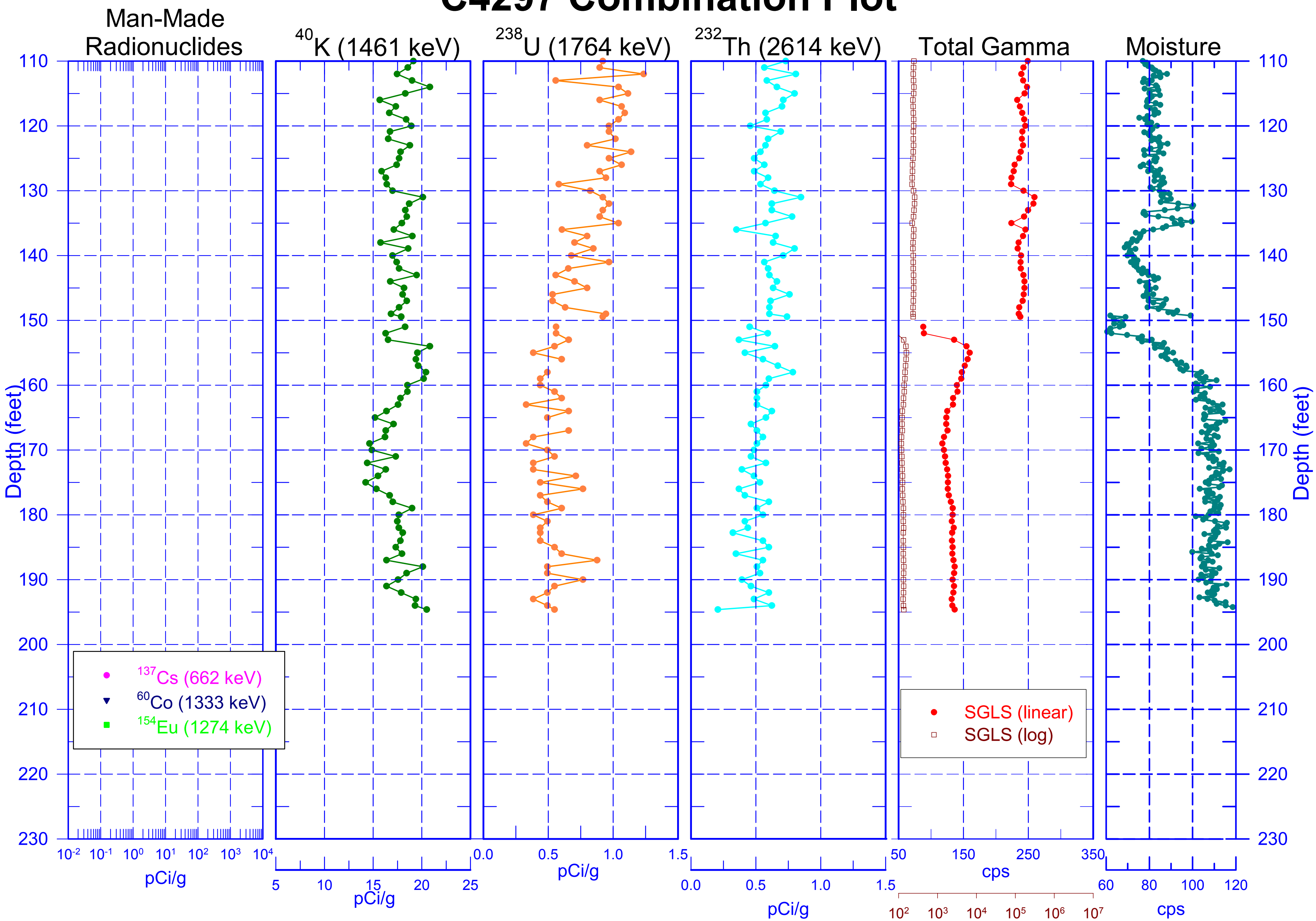
C4297 Combination Plot



Zero Reference = Ground Surface

Last Logging Date - 03/23/04

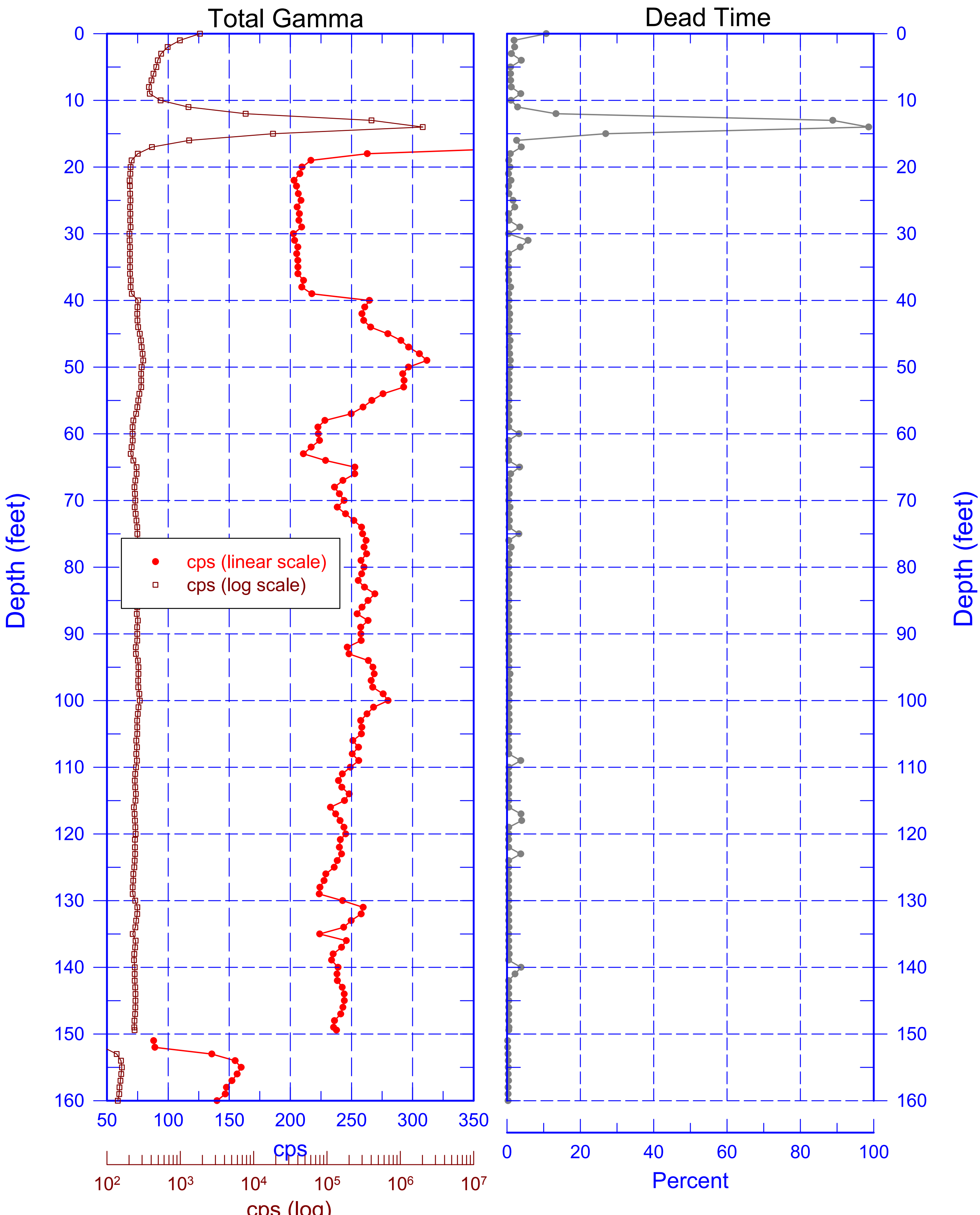
C4297 Combination Plot



Zero Reference = Ground Surface

Last Logging Date - 03/23/04

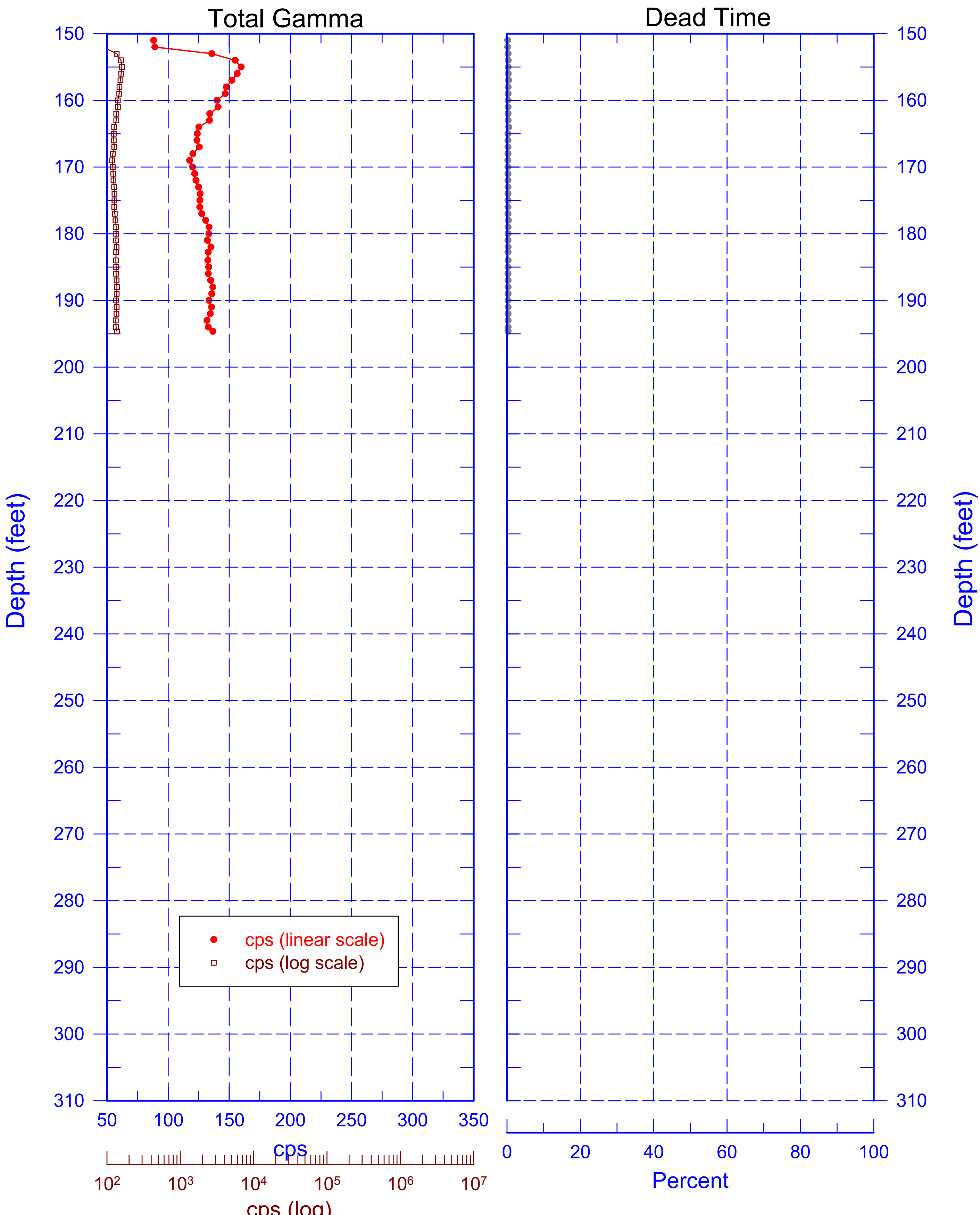
C4297
Total Gamma & Dead Time



Zero reference = Ground Surface

Last Log Date - 03/23/04

C4297
Total Gamma & Dead Time

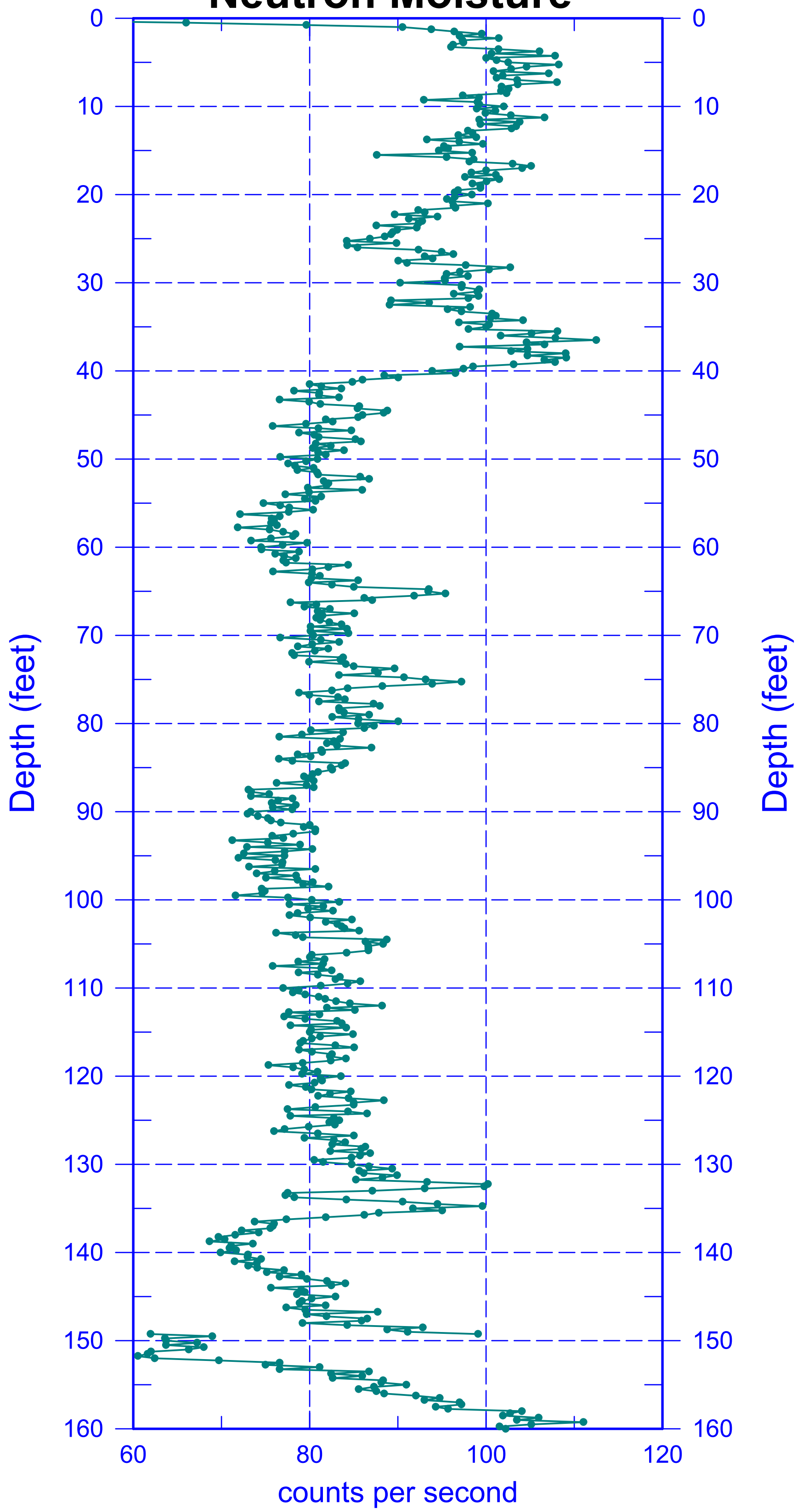


Zero Reference = Ground Surface

Last Log Date - 03/23/04

C4297

Neutron Moisture



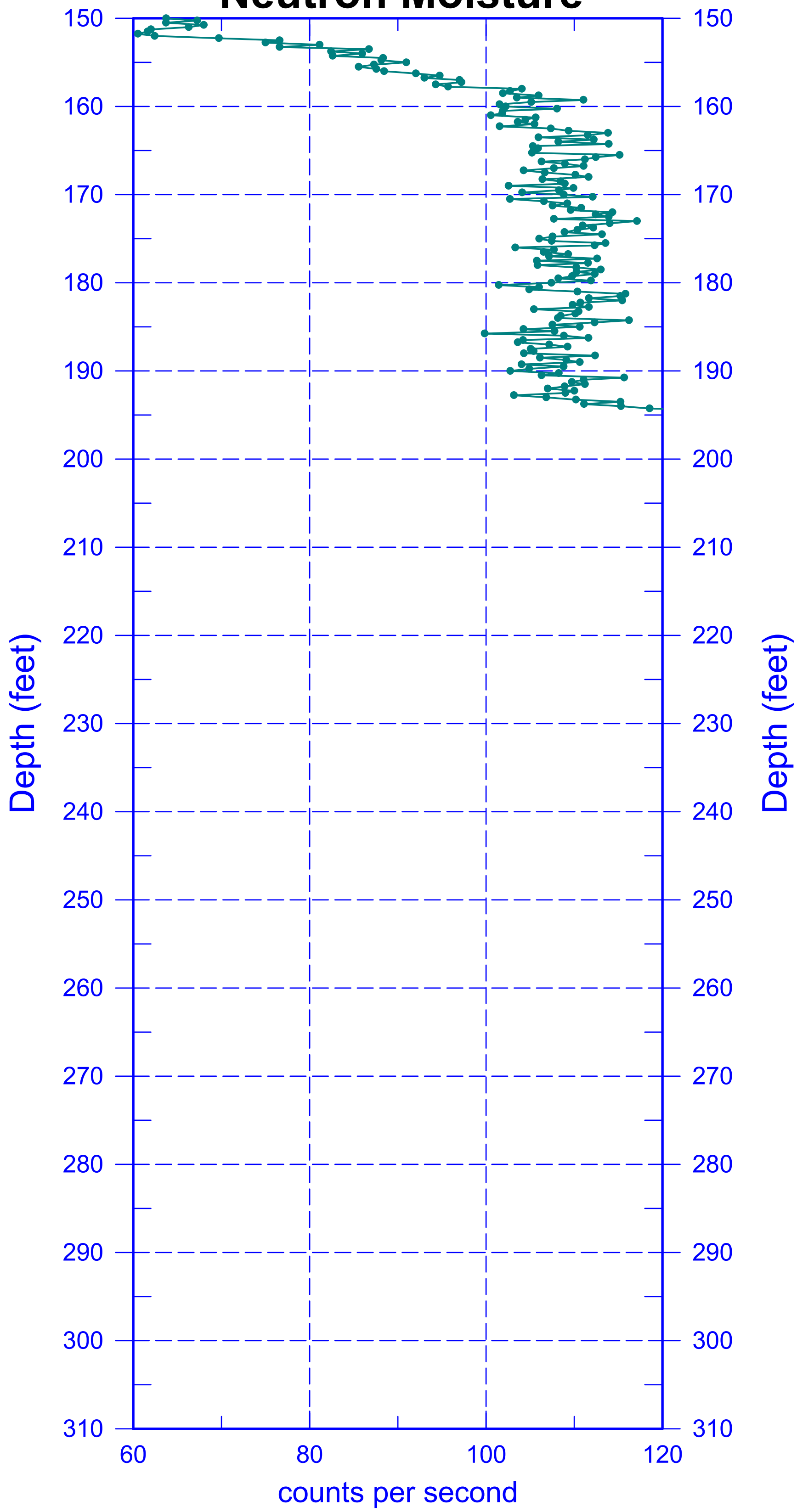
Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 03/23/04

C4297

Neutron Moisture



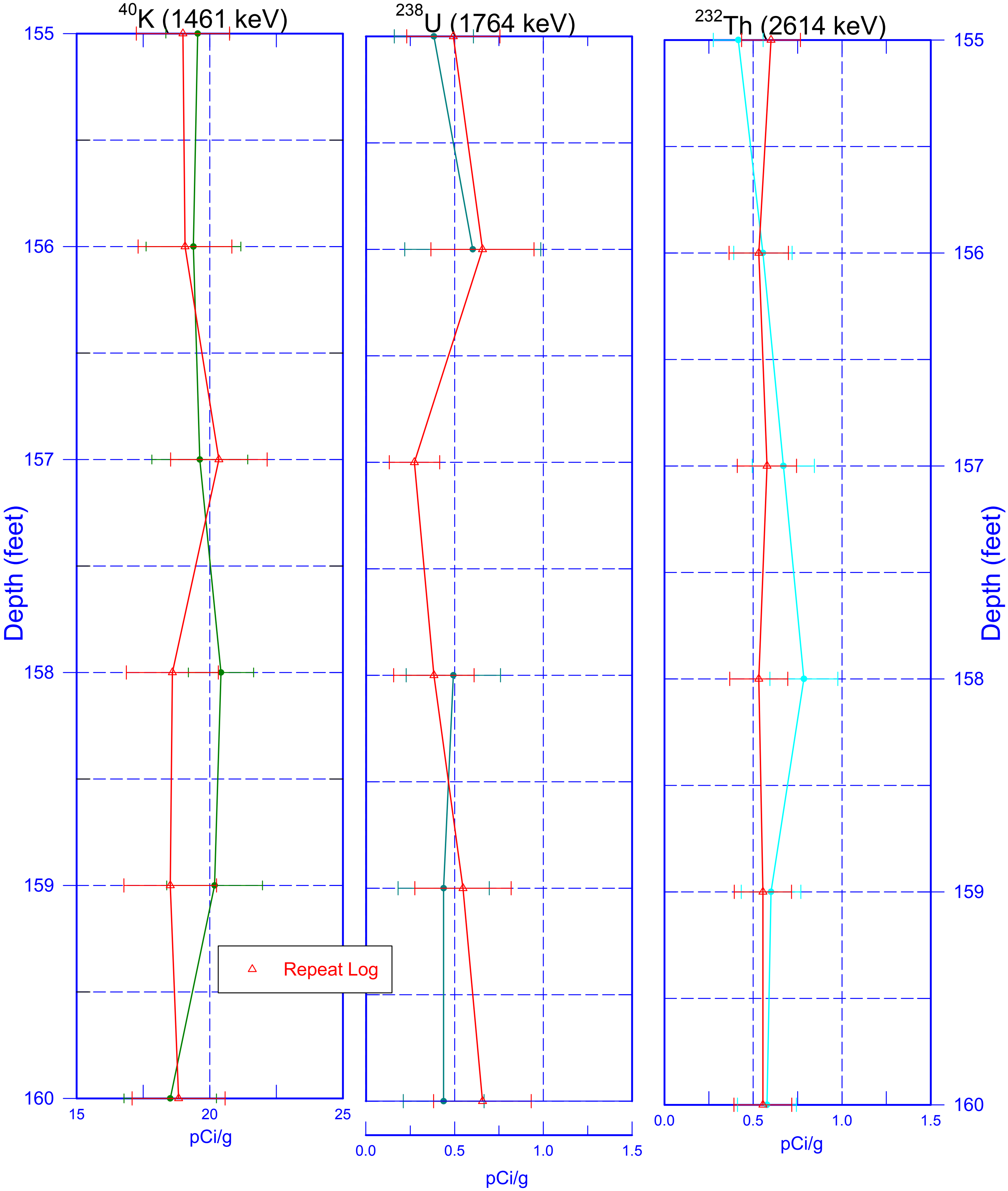
Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 03/23/04

C4297

Repeat Section of Natural Gamma Logs

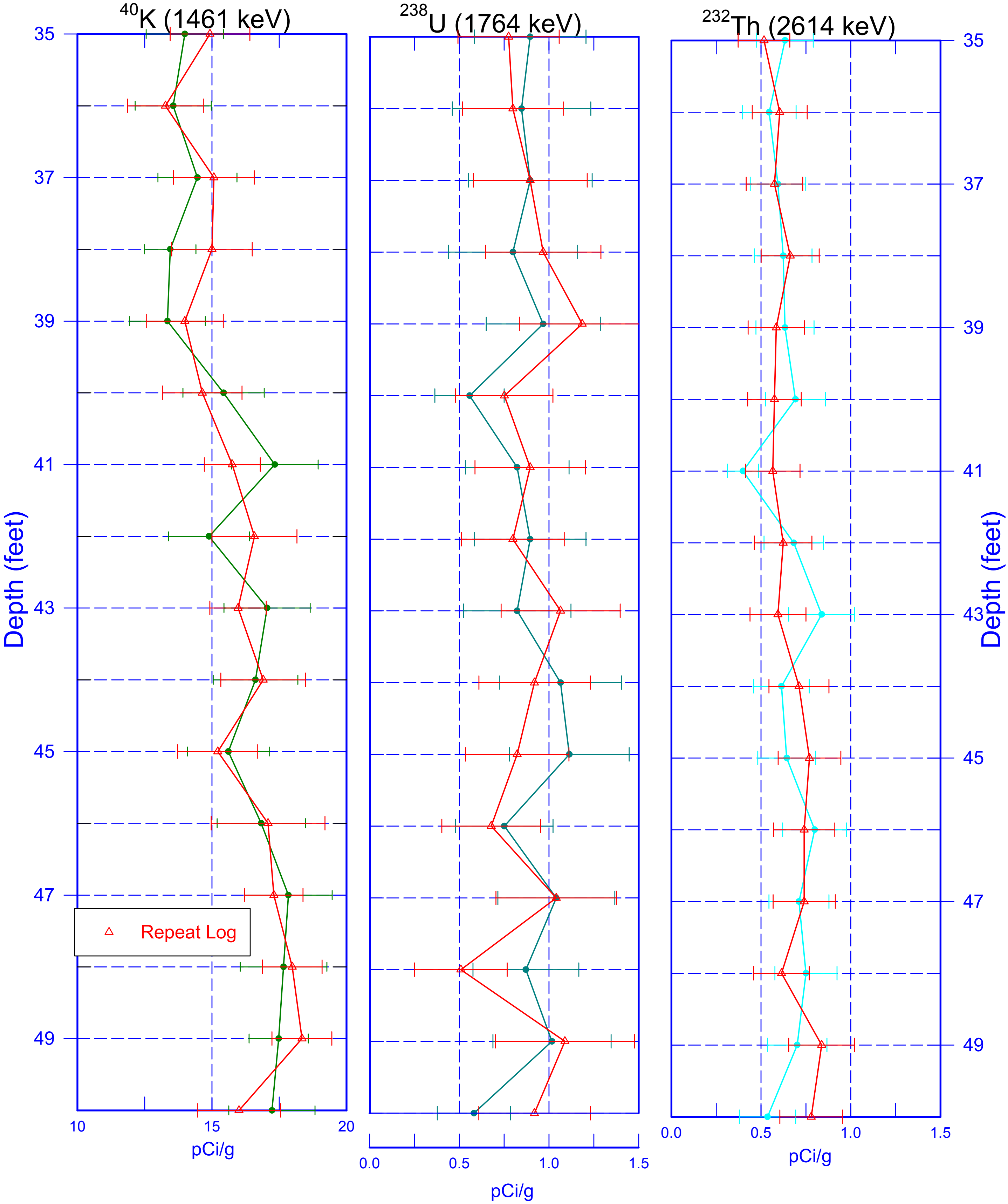


Zero Reference = Ground Surface

Last Log Date - 03/23/04

C4297

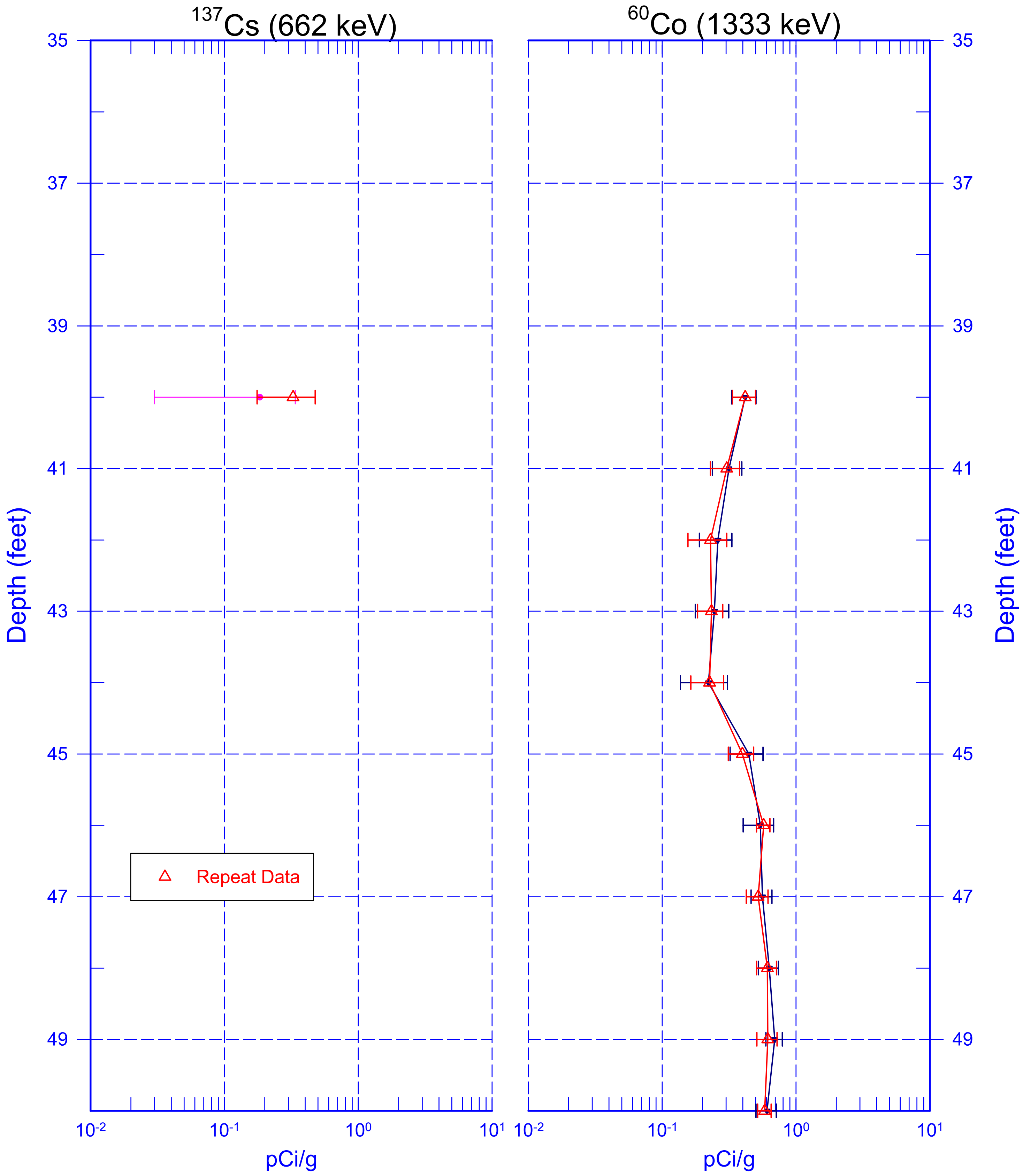
Repeat Section of Natural Gamma Logs



Zero Reference = Ground Surface

Last Log Date - 03/23/04

C4297
Repeat Section of Man-Made Radionuclides

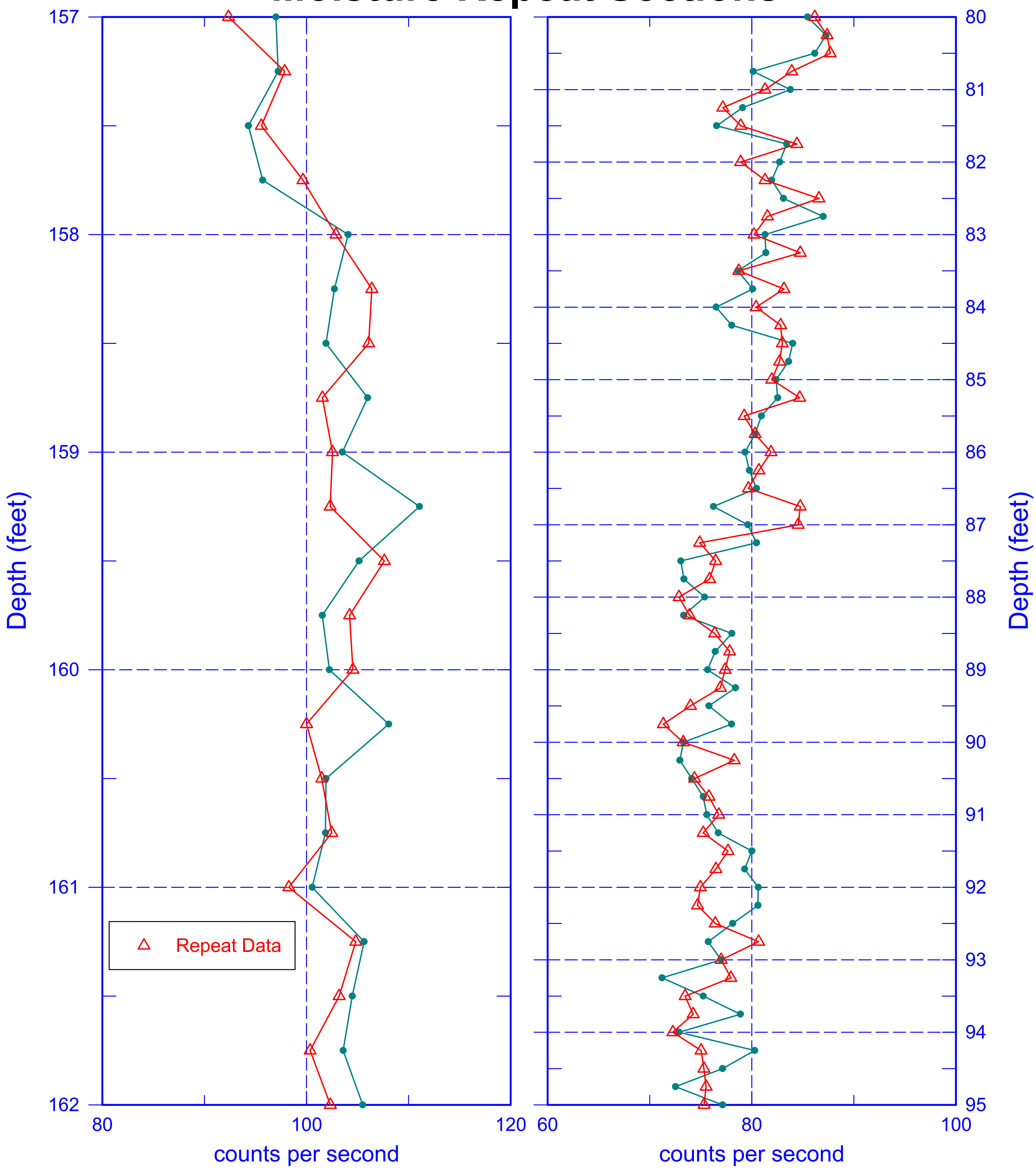


Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 03/23/04

C4297
Moisture Repeat Sections



Zero Reference = Ground Surface

Last Log Date - 03/23/04

Appendix H
Boreholes Projected for Retrieval Monitoring During the First Quarter of FY 2005

Table H-1. Boreholes Projected for Retrieval Monitoring During the 1st Quarter of FY 2005

Borehole Number	Tank	Top	Bottom	Footage	Next Log Date	Last Event Date	Projected 1st Qtr. Events	Total Events (to date)	Comment
30-00-01	C-106	0	65	65	03/31/04	03/01/04	1	8	No apparent change, C-106 Retrieval
30-03-01	C-103	0	124	124	05/17/97	04/17/97	1	0	Cannot log because of stairwell; C-103 Retrieval
30-03-03	C-103	0	97	97	05/11/97	04/11/97	1	0	Water in borehole 10/01, C-103 Retrieval
30-03-05	C-103	0	99	99	10/11/02	09/11/02	1	1	No apparent change, C-103 Retrieval
30-03-07	C-103	0	96	96	10/11/02	09/11/02	1	1	No apparent change, C-103 Retrieval
30-03-09	C-103	0	98	98	06/05/03	05/06/03	1	2	No apparent change, C-103 Retrieval
30-05-02	C-105	5	127	122	03/20/04	02/19/04	1	8	No apparent change, C-106 Retrieval
30-06-02	C-106	0	122	122	03/24/04	02/23/04	1	7	No apparent change, C-106 Retrieval
30-06-03	C-106	0	98	98	03/24/04	02/23/04	1	7	No apparent change, C-106 Retrieval
30-06-04	C-106	0	129	129	03/26/04	02/25/04	1	8	No apparent change, C-106 Retrieval
30-06-09	C-106	5	98	93	03/20/04	02/19/04	1	8	No apparent change, C-106 Retrieval
30-06-10	C-106	0	128	128	03/27/04	02/26/04	1	8	Possible change 124-126 ft Co-60, C-106 Retrieval
30-06-12	C-106	0	98	98	03/31/04	03/01/04	1	8	No apparent change, C-106 Retrieval
30-08-02	C-108	30	99	69	03/18/04	02/17/04	1	8	Def change in Co-60 49-75 ft, down move, C-106 Retrieval
30-09-06	C-109	30	98	68	03/21/04	02/20/04	1	7	No apparent change, C-106 Retrieval
30-09-07	C-109	30	121	91	03/18/04	02/17/04	1	7	No apparent change, C-106 Retrieval
40-02-01	S-102	0	129	129	08/01/03	07/02/03	2	2	No apparent change, S-102 Retrieval
40-02-03	S-102	0	98	98	08/07/03	07/08/03	2	1	Apparent Cs-137 increase at 44-47 ft., S-102 Retrieval
40-02-04	S-102	0	144	144	08/08/03	07/09/03	2	2	No apparent change, S-102 Retrieval
40-02-05	S-102	0	97	97	08/06/03	07/07/03	2	2	No apparent change, S-102 Retrieval
40-02-07	S-102	0	95	95	05/13/04	04/13/04	2	3	No apparent change, S-102 Retrieval
40-02-08	S-102	0	99	99	05/14/04	04/14/04	2	3	No apparent change, S-102 Retrieval
40-02-10	S-102	0	100	100	05/13/04	04/13/04	2	3	No apparent change, S-102 Retrieval
40-02-11	S-102	0	100	100	05/12/04	04/12/04	2	3	No apparent change, S-102 Retrieval
40-03-03	S-103	0	122	122	05/15/04	04/15/04	2	2	No apparent change, S-102 Retrieval
40-09-06	S-109	0	98	98	03/06/04	02/05/04	2	6	No apparent change; S-112 Retrieval
40-11-08	S-111	0	97	97	03/05/04	02/04/04	2	4	No apparent change, S-112 Retrieval
40-11-09	S-111	0	98	98	03/06/04	02/05/04	2	5	No apparent change, S-112 Retrieval
40-12-02	S-112	0	99	99	03/06/04	02/05/04	2	6	No apparent change; S-112 Retrieval
40-12-04	S-112	0	126	126	03/05/04	02/04/04	2	6	No apparent change; S-112 Retrieval
40-12-06	S-112	0	144	144	03/10/04	02/09/04	2	6	No apparent change; S-112 Retrieval
40-12-07	S-112	0	98	98	03/07/04	02/06/04	2	6	No apparent change; S-112 Retrieval
40-12-09	S-112	0	98	98	03/07/04	02/06/04	2	6	No apparent change; S-112 Retrieval
		Total Projected 1st Quarter Events =					**50**		

Table H-2. Boreholes Projected for Retrieval Moisture Logging During the 1st Quarter of FY 2005

Borehole Number	Tank	Top	Bottom	Footage	Next Event Date	Last Event Date	Projected 1st. Qtr. Events	Total Events (to date)	Comment
30-03-01	C-103	0	124	124	TBD	NA	1	0	No moisture logging performed to date.
30-03-03	C-103	0	97	97	TBD	NA	1	0	No moisture logging performed to date.
30-03-05	C-103	0	99	99	TBD	NA	1	0	No moisture logging performed to date.
30-03-07	C-103	0	96	96	TBD	NA	1	0	No moisture logging performed to date.
30-03-09	C-103	0	98	98	TBD	NA	1	0	No moisture logging performed to date.
30-05-02	C-105	0	127	127	03/12/04	02/11/04	1	6	Possible increase 42-70 ft
30-06-02	C-106	0	122	122	03/19/04	02/18/04	1	6	Possible increase 56-76 ft
30-06-03	C-106	0	98	98	03/18/04	02/17/04	1	6	Possible increase 57-68 ft
30-06-04	C-106	0	129	129	03/31/04	03/01/04	1	6	Possible increase 45-53 ft
30-06-09	C-106	0	98	98	03/13/04	02/12/04	1	6	Possible increase 50-72 ft
30-06-10	C-106	0	128	128	03/18/04	02/17/04	1	6	Possible increase 42-58 ft
30-06-12	C-106	0	98	98	03/19/04	02/18/04	1	6	Possible increase 50-60 ft
30-08-02	C-108	0	99	99	03/21/04	02/20/04	1	2	No apparent increase
30-09-06	C-109	0	98	98	03/13/04	02/12/04	1	2	No apparent increase
30-09-07	C-109	0	121	121	03/13/04	02/12/04	1	2	No apparent increase
40-02-01	S-102	0	129	129	05/08/04	04/08/04	2	1	Only one log, No comparison
40-02-03	S-102	0	98	98	05/07/04	04/07/04	2	1	Only one log, No comparison
40-02-05	S-102	0	97	97	04/24/04	03/25/04	2	1	Only one log, No comparison
40-02-07	S-102	0	95	95	04/30/04	03/31/04	2	1	Only one log, No comparison
40-02-08	S-102	0	99	99	05/06/04	04/06/04	2	1	Only one log, No comparison
40-02-10	S-102	0	100	100	05/06/04	04/06/04	2	1	Only one log, No comparison
40-02-11	S-102	0	100	100	04/24/04	03/25/04	2	1	Only one log, No comparison
40-03-03	S-103	0	122	122	04/08/04	04/08/04	2	1	Only one log, No comparison
40-09-06	S-109	0	98	98	03/10/04	02/09/04	2	4	Possible increase 40-50 ft
40-11-08	S-111	0	96	96	05/14/04	04/14/04	2	4	None
40-11-09	S-111	0	98	98	03/07/04	02/06/04	2	3	Possible increase 23-33 ft
40-12-02	S-112	0	99	99	03/07/04	02/06/04	2	4	Possible increase 32-47 ft
40-12-04	S-112	0	126	126	05/14/04	04/14/04	2	5	Possible increase 53-55 ft
40-12-06	S-112	0	144	144	03/11/04	02/10/04	2	4	Possible increase 35-49 ft
40-12-07	S-112	0	96	96	03/11/04	02/10/04	2	4	Possible increase 23-43 ft
40-12-09	S-112	0	99	99	03/10/04	02/09/04	2	4	Possible increase 37-50 ft
			Total Projected 1st Quarter Events =				**47**		